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A list of ants from Lambir Hills National Park and its vicinity, with their biological information: Part I. Subfamilies Myrmicinae and Pseudomyrmecinae

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ABSTRACT A list of myrmicine and pseudomyrmecine ants from Lambir Hills National Park, Sarawak, Borneo is presented with biological information. A total of 227 species (214 in Myrmicinae and 13 in Pseudomyrmecinae) in 30 genera (29 and 1 respectively) are recorded, of which 133 (58.6%) are identified at species level. The most specious genus is *Creamatogaster* (46 species), followed by *Tetramorium* (30), *Strumigenys* (23), and *Pheidole* (22). Nine species are newly recorded from Borneo: *Strumigenys epyna*, *S. nesterix, Crematogaster ransonneti*, *C. simboloni*, *Tetramorium eleates*, *Vollenhovia longicephala* and *V. modiglianii.* Papers treating Myrmicinae and Pseudomyrmecinae of Lambir Hills National Park are listed.

KEY WORDS ant-plant symbiosis / arthropod diversity / Borneo / dipterocarp forest / Formicidae / insect fauna / Sarawak / Southeast Asian tropical rainforests

Introduction

Borneo, composed of Sabah and Sarawak (Malaysia), Kalimantan (Indonesia) and Brunei, is a huge tropical island with an area of ca. 743,300 km^2, the third world largest island. Before Alfred Wallace visited there during the mid-nineteenth century, Borneo had been mostly covered with tropical rainforests and other kinds of tropical forests inhabited by rich fauna and flora. After the Second World War the forests have been heavily logged, currently leaving isolated patches in lowlands and more continuous belts in the central mountain range. Most primary forest areas, probably more than 80% of the total, have been replaced with secondary forests, plantations of oil palm, fruits and rubber tree, and other human-dominated habitats. This has forced many large animals to near extinction, and deprived forest insects of their suitable habitats.

The impoverishment of ant fauna in replaced habitats, especially in oil palm plantations, has been documented mainly in Sabah (Eltz & Brühl 2001; Brühl & Eltz 2010; Wang & Foster 2015, 2016). In Sarawak, where Lambir Hills National Park is

located, a fewer studies are available on this topic. Kishimoto-Yamada et al. (2013) showed that the presence of patchy primary forests positively affected the ant species richness in surrounding secondary forests. This suggests the role of patchy primary forests in supplying other patches with species locally extinct in the latter through intervening secondary forests. Matsumoto et al. (2009) compared the rate of encounters with army ants of the genus *Aenictus* among five forest types in a swidden agricultural area in Sarawak, and found that younger secondary forests tended to have poorer army ant fauna and lower encounter rates.

Lambir Hills National Park is an isolated lowland primary forest close to Miri, Sarawak (Hazebroek & Abang Kashim 2006). It is surrounded by secondary forests, oil palm plantations, crop fields and human habitation. Although it lacks most of large mammals like orang-utan, sun bear, leopard, banteng etc., its tree flora is extraordinarily rich with more than 1,200 species that is compatible to the entire tree flora in Japan (Lee et al. 2002; Inui & Itioka 2016). A variety of researches have been conducted there to reveal the nature of general flowering (Inoue & Hamid 1997), seasonality in some insect groups (Kishimoto-Yamada et al. 2009, 2010; Kishimoto-Yamada & Itioka 2013), complicated food webs (Nakagawa et al. 2003; Hyodo et al. 2010), and ant-plant symbiosis (see below). Arthropod fauna has also been documented for some groups such as light-attracted beetles (Kato et al. 2000), scarabaeid beetles (Matsumoto 2015), tenebrionid beetles (Ando et al. 2017), butterflies (Itioka et al. 2009), and other groups.

In spite of the importance of ants as ecosystem engineers (Itioka 2016), no comprehensive list of ants from Lambir Hills National Park has been compiled. In this paper we list all the ant species collected so far in this forest together with their biological information. As the first part the subfamilies Myrmicinae and Pseudomyrmecinae are treated.

Survey sites and methods

Collection sites

Lambir Hills National Park principally consists of lowland dipterocarp and heath forests, with the highest point (Bt. Lambir) being 465 m above sea level and an area of around 7,000 ha (Hazebroek & Abang Kashim 2006). Only part of the park has been explored to collect and observe ants, probably covering much less than 100 ha in area (Fig. 1). Most samples were collected in areas around the head quarters, mainly in the 8 ha plot and Canopy 4 ha that are covered with primary forests (Pls. 1, 2). The survey sites consisted of the following nine areas.

Head quarters: small area facing the main road connecting Miri and Bintulu,

with the head office, a small exhibition building, cottages and field laboratory (Tamiji House), equipped with lights that attract insects during night; some light-attracted winged ants were collected here.

8 ha plot: dipterocarp forest close to the head quarters, with trails, two tree towers, walkways connecting the towers (298 m in total length at the time of their original completion); large part of ant specimens were collected from this plot; forest edge harbors a rich insect fauna; light trapping has been conducted on the first tree tower at various heights, but the ant samples are left untouched.

Tourist area: this is the only place open to public people for recreation, starting at the head quarters ending at a waterfall via a forest trail of around 0.9 km; some tramp ants are found along the trail.

Canopy 4 ha (Pl. 1: 1, 3): a canopy crane covering from the ground level up to 80 m high and 75 m radius. H.O. Tanaka made an intensive survey on the nesting sites and interspecific interaction of ants in the canopy, yielding a lot of ant samples, most of which are not yet thoroughly studied taxonomically.

Inoue trail: starting at the head quarters and going up toward Canopy 4 ha.

Bukit Pantu: located near the center of the park, with an elevation of ca. 300 m.

50 ha plot: actually with 52 ha, located along the climbing rout of Bukit Lambir; a long-term survey of forest dynamics has been conducted here; only a small part of ant samples came from this plot.

Bukit Lambir: located in mid-west part of the park, with the highest peak of 465 m in altitude; only a small portion of ant samples came from this hill.

Sungai Liku: located near the northern border in the east part of the park.

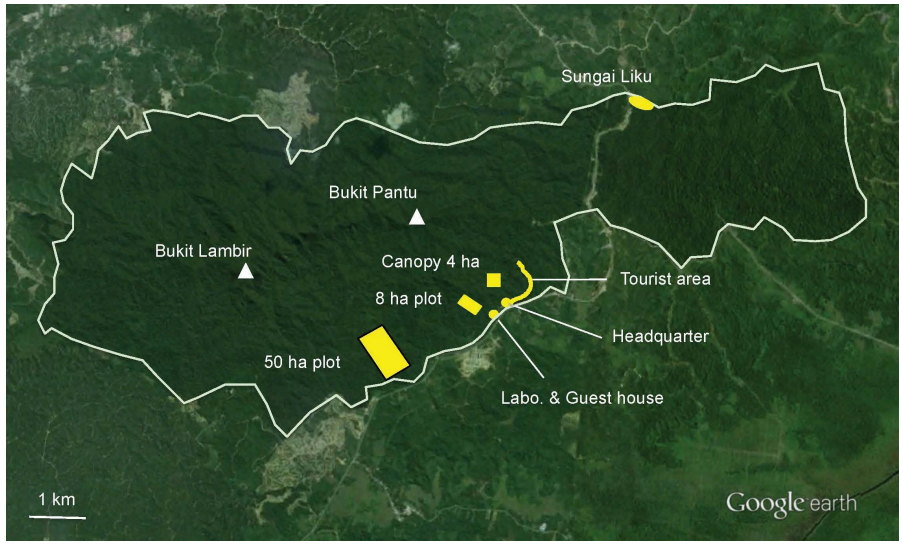

Fig. 1 Location of the nine areas for survey in Lambir Hills National Park.

Collection methods

Ants were collected manually with forceps or aspirators by searching decayed wood, stones, leaf litter etc. on the ground surface, tree trunks near the ground surface, foliage of plants at forest floor (Pl. 2: 8, 9) and higher parts of the forest canopy from the tree towers, walkways and canopy crane, and by directly climbing trees (Pl. 1: 2–4). Ground level ant fauna was studied using honey (sugar) baits; arboreal ants were net-swept to compare ant species composition between different sites. Biological information was got mainly by colony collection, baiting and direct observations (see below). Numerous wet specimens (mainly winged ants) sampled by light trapping have not yet been identified.

Identification and arrangements of species

Identifications at genus level were made mainly by consulting Bolton (1994). A comprehensive classification system of Formicidae was given by Bolton (2003). However, in recent five years new taxonomic systems of ants have been proposed principally based on DNA phylogenies (Boudinot 2015 for entire Formicidae; Brady et al. 2014 for Dorylinae; Schmidt & Shattuck 2014 for Ponerinae; Ward et al. 2014 for Myrmicinae; Ward & Fisher 2016 for Amblyoponinae; Ward et al. 2016 for Formicinae). In this paper we principally follow the system in Ward et al. (2014), although all of us do not necessarily agree to it.

Species are listed alphabetically for each genus, or for each subgenus or species-group in the genera having more than one subgenus or species group. Species entries also include those with 'cf. names' like *Tetramorium* cf. *rawlinsoni* (Taylor 1992), although they are counted as unidentified species in statistics. SKY species codes, when available, are given in parentheses following species names. Unidentified species without 'cf. names' are listed by SKY species codes at the end of each genus, subgenus or species group. Each of the species newly recorded from Borneo is indicated by an asterisk; many of unidentified species might be new to Borneo or even new to science. In cases where detailed location data are not available on data labels, the collection site is simply described as 'Lambir'.

All the photos of ant specimens (Plates 3-15) were taken by Y. Hashimoto. Digital stacked images of specimens were acquired with a digital camera attached to automated macro rail (StackShot™, Cognisys Inc.) and stacked with Zerene-Stacker™, Zerene Systems LLC) software. The photographed specimens are given voucher codes (unique specimen identifiers: USI) and preserved in the Entomological Collection, Hyogo Prefectural Museum, Sanda, Japan. A set of specimens of the species listed below will be deposited in Forest Research Centre (Kuching), Forest Department Sarawak.

Sources of biological data

Information written on data labels of specimens and in SKY's field notebooks is mainly used. Some papers dealing with ants observed in Lambir also contain biological information. Unpublished data are occasionally cited for species observed/found in canopies (H.O. Tanaka), in the transects for soil CO_2 emission study (M. Ohashi group; Pl. 2: 11), those net-swept at different strata of dipterocarp forests in ant-mimicking-spider study (Y. Hashimoto group), and those found to be attracted to *Endospermum* extra-floral nectaries by Sk. Yamane and H.O. Tanaka.

Abbreviations

The following abbreviations are used in the list and figure captions. Sexes and castes: w, worker; fq, dealate queen (mostly founding queen); wq, winged queen; m, male. Collection sites: Bt., Bukit (hill); HQ, head quarters. Collectors: HOT, H.O. Tanaka; SKY, Sk. Yamane.

List of myrmicine and pseudomyrmecine ants

Subfamily Myrmicinae

Up to now 315 named species (332 if subspecies included) in 42 myrmicine genera have been recorded from Borneo (Pfeiffer et al. 2011). We recognized 208 species, including 91 unidentified species, belonging to 29 genera in Lambir Hills National Park and its environs. With regard to genus-level classification Pfeiffer et al. (2011) adopted a system (mainly based on Bolton 2003) different from that we follow in this paper (see Ward et al. 2014).

Tribe Stenammini Ashmead, 1905

Genus *Aphaenogaster* Mayr, 1853

Named Bornean species: 0 (Pfeiffer et al. 2011). Lambir species: 1 (unidentified). It belongs to 'the subgenus *Deromyrma* Forel, 1913', in which the head is elongate, distinctly narrowed posteriorly to form a 'neck'.

Unidentified species in *Aphaenogaster*: **sp. 26 of SKY** (8 ha plot & Tourist area; nests in clay; attracted to honey baits; active day and night; Pl. 4: 23 [USI: B2356474]).

Literature. Ohashi et al. (2017), Yamane et al. (1996; as *Aphaenogaster* sp. 2).

Tribe Solenopsidini Forel, 1893

Genus *Epelysidris* Bolton, 1987
Named Bornean species: 1 (Pfeiffer et al. 2011; as a species of *Monomorium*). Lambir species: 1 (unidentified). *Epelysidris* was synonymized with *Monomorium* by Fernández (in Heterick 2006) and Fernández (2007), but revived as a distinct genus by Ward et al. (2014). Social biology and male morphology were studied by Ito & Yamane (2014).

Epelysidris* cf. *brocha Bolton, 1987 (sp. 3 of SKY)
Collection data. 'Lambir': w, 13.vii.2010, LL3-18, ex soil, Y. Maekawa.

Genus *Myrmicaria* Saunders, 1842
Named Bornean species: 6 (Pfeiffer et al. 2011); Lambir species: 9 (6 named, 3 unidentified). The Asian species are classified to two species groups, i.e., the *M. arachnoides* group and *M. brunnea* group. All the species of the former group construct carton nests on plant (mainly tree) leaves, while those of the latter group nest underground (Bakhtiar et al. 2009). In Lambir a little is known of the biology of *Myrmicaria*. Some species of the *M. brunnea* group are attracted to honey baits, homopteran honeydews (Pl. 2: 15) and *Endospermum* extrafloral nectaries.

M. arachnoides F. Smith group

Myrmicaria arachnoides adpressipilosa Santschi, 1928 (sp. 12 of SKY)
Collection data. 8 ha plot: w, 20.i.1993, honey bait, night, SKY. Tourist area: w, 4.viii.1995, H. Okido.
Taxonomic notes. This has been treated as a subspecies of *M. arachnoides* (F. Smith 1857), but is undoubtedly a distinct species (Bakhtiar & Yamane in preparation).

Myrmicaria arachnoides (F. Smith, 1857) (sp. 3 of SKY; = *sp. 9 of SKY*)
Collection data. 'Lambir': w, 21–27.ii.2009 (ant-mimic sample: 09F-42-1).
Biology. Forest edge; arboreal; attracted to honey baits; active in night.
Literature. Yamane et al. (1996), Katayama et al. (2012).

Myrmicaria birmana Forel, 1902 (sp. 4 of SKY)
Collection data. 'Lambir': w, 6.vii.2005, HOT (H311.13, AT0753).
Literature. Pfeiffer et al. (2011).

Myrmicaria melanogaster Emery, 1900 (sp. 2 of SKY) (Pl. 4: 24 [USI: B2356475])
Collection data. 8 ha plot: w, 31.i.1993, SKY; w, 3.iii.1997. walkway, SKY; w, 10.ix.2006, on leaf, walkway, HOT (AT1193). 'Lambir': w, 10.x.2008, M. Yoshima (61-L20/YM-0364); w, 3–12.ix.2009 (ant-mimic sample #322).
Biology. Forest; arboreal.

Literature. Katayama et al. (2012).

Unidentified species in *M. arachnoides* group: **sp. 10 of SKY** (= *sp. 2*, part) (8 ha plot & 'Lambir').

M. brunnea Saunders group (Pl. 2: 15)

Myrmicaria brunnea flava Forel, 1913 (sp. 8 of SKY)

Collection data. Tourist area: w, 20–22.i.1993, SKY; w, 30.xii.1997, SKY (SR97-SKY-103); w, 22.iii.2013, on *Shorea* tree, SKY (SR13-SKY-11). HQ: m, 16.xii.1993, SKY. 50 ha plot: w, 27.i.1993, SKY.

Biology. Forest; arboreal.

Myrmicaria brunnea subcarinata (F. Smith, 1857) (sp. 13 of SKY)

Collection data. 8 ha plot: w, 27.viii, 1994, T. Itioka & T. Yumoto (#118); w, 30.xii.1997, F. Yamane. Tourist area: w, 15.xii.1993, SKY; w, 30.xii.1997, SKY (SR97-SKY-103, 108). Bt. Pantu: 2.i.1998, F. Yamane. 'Lambir': w, 2.vi.1992, on *Uvaria grandiflora* flower, T. Nagamitsu (UV1-4, 44–50); w, 2.i.1998, SKY.

Taxonomic notes. This form has been treated as a subspecies of *M. brunnea* Saunders, 1842, but is undoubtedly a distinct species (Bakhtiar, personal communication).

Unidentified species in *M. brunnea* group: **sp. 6 of SKY** (8 ha plot), **sp. 14 of SKY** (8 ha plot).

Genus *Monomorium* Mayr, 1855

Named Bornean species: 4 (Pfeiffer et al. 2011); Lambir species: 9 (2 named & 7 unidentified). *Epelysidris* established by Bolton (1987) was once synonymized with *Monomorium* (Fernández in Heterick 2006), but later revived as a distinct genus (Ward et al. 2014; see under *Epelysidris*).

Monomorium floricola (Jerdon, 1851) (sp. 11 of SKY)

Collection data. 8 ha plot: w, 6–14.i.1993, tree tower, 35 m above ground, SKY; w, 26–27.viii.1994, T. Itioka & T. Yumoto; w, 23–24.viii. 1995, tree tower–walkway, SKY. HQ: w, 7.i.1993, SKY. Canopy 4 ha: w, 3.iii.2004, HOT (P1B5-1B); w, 6.iii.2004, HOT (P6B4-3).

Biology. Disturbed area and forest; often arboreal.

Monomorium* cf. *monomorium Bolton, 1987 (sp. 4 of SKY)

Collection data. HQ: w, 3–24.viii.1995, SKY.

Biology. Disturbed area; ground level.

Monomorium pharaonis (Linnaeus, 1758) (sp. 19 of SKY)

Collection data. 8 ha plot: w, 22.i.1993, at night, SKY; w, 30.vi.2004, leaf litter, SKY. Canopy 4 ha: w, 8.iii.2004, HOT (P9B87); w, 2.vii.2004, HOT (AT0271).

Biology. Forest; ground level to lower vegetation; active at night. Although

generally collected in disturbed habitats in tropical Asia, this species has not been collected around HQ.

Unidentified species in *Monomorium*: **sp. 1 of SKY** (8 ha plot; attracted to cheese baits), **sp. 5 of SKY** (nr Canopy 4 ha & Sungai Liku, carton nest on tree leaf; Katayama et al., 2012; Pl. 3:21, 22; Pl. 4: 25 [USI: B2356476]), **sp. 8 of SKY** (8 ha plot & 'Lambir'), **sp. 28 of SKY** (Canopy 4 ha), **sp. A** ('Lambir'), **sp. B** (Canopy 4 ha & 'Lambir').

Genus *Solenopsis* Westwood, 1840

Named Bornean species: 1 (Pfeiffer et al. 2011); Lambir species: 1 (unidentified). The famous tramp species *S. geminata* (Fabricius, 1804) has not yet been collected in Lambir even around the head quarters at least until 2000, although it is common in disturbed areas of Sabah.

Unidentified species in *Solenopsis*: **sp. 1 of SKY** (8 ha plot & Tourist area).

Genus *Syllophopsis* Santschi, 1915

Named Bornean species: 2 (as *Monomorium australicum* Forel, 1907 and *M. sechellense* Emery, 1894 in Pfeiffer et al. 2011). Lambir species: 1 (named).

Syllophopsis australicus (Forel, 1907) (sp. 2 of SKY) (Pl. 5: 26 [USI: B2356477])

Collection data. 8 ha plot: w, 15.i.1993, SKY.

Tribe Attini F. Smith, 1858

Genus *Pheidole* Westwood, 1839

Named Bornean Species: 56 (Eguchi 2001; Pfeiffer et al. 2011). Eguchi (2001) recorded 17 species of this genus from Lambir Hills National Park. Here we list 22 species (2 species unidentified), of which a few were identified tentatively. Most species are forest floor inhabitants. Famous tramp ants, *Pheidole megacephala* (Fabricius, 1793) and *P. parva* Mayr, 1865-complex (referred to as *P. bugi* Wheeler, 1919 in Eguchi 2001 and Pfeiffer et al. 2011) have not yet been collected from our research site. Although Eguchi (2001) recorded the tramp *P. fervens* (F. Smith, 1858) from Sabah, Sarawak (Niah) and E. Kalimantan, we did not encounter it in Lambir.

Pheidole aglae Forel, 1913 (sp. 46 of SKY)

Collection data. 8 ha plot: w, SKY. 'Lambir': w & m, 1996, K. Eguchi (Eg98-BOR-805) (Eguchi 2001, p. 28).

Biology. Forest; ground level and lower vegetation; nests in soil (Ohashi et al. 2017).

Literature. Eguchi (2001), Tanaka et al. (2010), Ohashi et al. (2017).

Pheidole angulicollis Eguchi, 2001

Collection data. 'Lambir': w, 1997, SKY (97-01) (also see Eguchi 2001, p. 30).

Literature. Eguchi (2001).

Pheidole aristotelis Forel, 1911 (sp. 12 of SKY)

Collection data. 'Lambir': w, 15.viii.1995, M. Kato, ex *Polypodium* sp.

Biology. Forest; ground level; nests in soil (Ohashi et al. 2017).

Literature. Eguchi (2001), Ohashi et al. (2017).

Pheidole butteli Forel, 1913 (sp. 39 of SKY)

Collection data. 'Lambir': w & q, 1998, K. Eguchi (Eguchi 2001, p. 39).

Literature. Eguchi (2001).

Pheidole cariniceps Eguchi, 2001 (sp. 58 of SKY; also *sp. 1(b) of SKY*)

Collection data. 8 ha plot: w, 13.i.1993, G-1-9, SKY; w, 15.i.1993, G-3-9, SKY; w, 20.viii.1994, #116, T. Itioka & T. Yumoto.

Biology. Forest; ground level including lower vegetation; attracted to sugar baits; active in day and night.

Literature. Itino & Yamane (1995; as sp. 1(b)), Yamane et al. (1996; as sp. 1(b)), Eguchi (2001).

Pheidole clypeocornis Eguchi, 2001 (sp. 19 of SKY)

Collection data. 8 ha plot: w & m, 30.vi.2004, rotting wood, SKY (SR04-SKY-59); w, same data (SR04-SKY-62). Tourist area: w, 15.xii.1993, SKY. Trail to Canopy 4 ha: w & wq, 3.vii.2004, rotting wood, SKY (SR04-SKY-90).

Biology. Forest; ground level; nests in rotting wood.

Pheidole ghigii Emery, 1900 (sp. 9 of SKY)

Collection data. Tourist area: w, 30.vi.2004, SKY (SR04-SKY-19). 'Lambir': w, 25-28.iv.2011, LL6-3, 16, in soil, T. Kume; w, 15.v.2011, LL9-27, 29, 30, in soil, Y. Maekawa; w, 17.v.2011, LL10-9, in soil, M. Ohashi.

Biology. Forest; ground level; nests in soil (0–30 cm deep).

Pheidole gombakensis Eguchi, 2001

Collection data. 8 ha plot: 30.vi.2004, leaf litter, SKY (SR04-SKY-56).

Biology. Forest; ground level; colony found from leaf litter.

Pheidole* cf. *hortensis Forel, 1913

Collection data. 'Lambir': w, 6.xii.2012, lower vegetation (ant-mimic sample; 20121206-H39G).

Pheidole huberi Forel, 1911 (sp. 3 of SKY)

Collection data. 8 ha plot: 15.i.1993, SKY. Tourist area: w, 16.viii.1997, SKY.

Biology. Forest, ground level including lower vegetation; attracted to honey baits.

Literature. Yamane et al. (1996), Eguchi (2001).

Pheidole lucioccipitalis Eguchi, 2001 (sp. 4 of SKY, also *sp. 14 of SKY*)

Collection data. 8 ha plot: w, 11.i.1993, SKY. Tourist area: w, 12.i.1993, SKY; w, 24.i.1993, SKY.

Biology. Forest; ground level including lower vegetation; attracted to sugar baits; active in day and night.

Literature. Itino & Yamane (1995; as sp. 14 of SKY), Yamane et al. (1996), Eguchi (2001), Tanaka et al. (2010), Ohashi et al. (2017).

Pheidole merimbun Eguchi, 2001 (sp. 7 of SKY; also *sp. 23 of SKY*)

Collection data. 8 ha plot: w, 30.i.1993, T-1-7, SKY; w, 27.viii.1994, #63, T. Itioka & T. Yumoto. 'Lambir': w, 3.ix.2005, I083.14 AT0957, HOT.

Biology. Forest; ground level to canopy; nests under bark of living tree; attracted to sugar baits; active in daytime.

Literature. Tanaka et al. (2010), Tanaka & Itioka (2012).

Pheidole parvicornis Eguchi, 2001

Collection data. Tourist area: w, 30.vi.2004, leaf litter, SKY (SR04-SKY-25). Inoue trail: w, 24.iii.2013, SKY.

Biology. Forest; ground level; a colony collected from leaf litter.

Pheidole plagiaria F. Smith, 1860 (sp. 1 of SKY; also *sp. 1(a) of SKY*) (Pl. 5: 27 [USI: B2356478], 28 [USI: B2356479])

Collection data. 8 ha plot: w, 13.i.1993, G-1-7, SKY; w, 20.i.1993, GN-3-8, SKY. Inoue trail: w, 2.vii.2004, cheese bait, SKY (SR04-SKY-67); w, 24.iii.2013, SKY (SR13-SKY-37). 50 ha plot: w, 7.i.1993, SKY.

Biology. Forest, ground level including lower vegetation; attracted to sugar and cheese baits; nests in soil (Ohashi et al. 2017); prey of *Aenictus dentatus* Forel, 1911 (Hashimoto & Yamane 2014); active in day and night. One of the most common *Pheidole* species in our research site.

Literature. Yamane et al. (1996), Tanaka et al. (2010), Eguchi (2011), Katayama et al. (2012), Hashimoto & Yamane (2014), Ohashi et al. (2017).

Pheidole quadrensis Forel, 1900 (sp. 2 of SKY)

Collection data. 8 ha plot: w, 26.i.1993, SKY.

Literature. Eguchi (2001).

Pheidole rugifera Eguchi, 2001 (sp. 20 of SKY)

Collection data. 8 ha plot: w, 22-23.i.1993, SKY; w, 10.viii.1995, SKY; w, 17.viii.1997, SKY.

Biology. Forest.

Pheidole sabahna Eguchi, 2000

Collection data. 8 ha plot: w, 3.i.1998, SKY. 'Lambir': w, 21–27.ii.2009, lower vegetation, Y. Hashimoto (090227-e8).

Biology. Forest; ground level including lower vegetation.
Literature. Eguchi (2000, 2001).

Pheidole sauberi Forel, 1905 (sp. 5 of SKY; also *sp. 7, 44 of SKY*)
Collection data. 8 ha plot: w, 16.i.1993, SKY; w, 30.vi.2004, rotting wood, SKY (SR04-SKY-64). Inoue trail: w, 2.vii.2004, cheese bait, SKY (SR04-SKY-39); w, 2.vii.2004, rotting wood, SKY.
Biology. Forest; ground level; nests in rotting wood; attracted to cheese baits.
Literature. Eguchi (2001).

Pheidole singaporensis Uzdikmen, 2010
Collection data. 8 ha plot: w, 15.i.1993, SKY.
Taxonomic notes. This species is closely related to *P. comata* F. Smith, 1858 recorded from Borneo and southern Malay Peninsula, and morphologically separated from the latter only in the major worker (Eguchi 2001). Unfortunately we have no majors from Lambir. However, *P. comata* has so far been collected at higher altitudes from 500 m to 1,100 m. Here we tentatively identify Lambir specimens as *P. singaporensis*. *Pheidole longipes* (F. Smith, 1857) (original combination: *Myrmica longipes*) is a junior secondary homonym of *Pheidole longipes* (Latreille, 1802) (original combination: *Formica longipes*) (Uzdikmen 2010).
Biology. Forest; ground level.
Literature. Eguchi (2001), Ohashi et al. (2017; as cf. *longipes*).

Pheidole spinicornis Eguchi, 2001 (sp. 17 of SKY)
Collection data. Tourist area: w, 22.i.1993, SKY.
Biology. Forest; ground level; nests in soil.
Literature. Eguchi (2001), Ohashi et al. (2017).

Pheidole tawauensis Eguchi, 2001
Collection data. 'Lambir': w, 12-15.v.2011, LL9-4,27, in soil, Y. Maekawa; w, 11.i.2012, LL11-28, in soil, M. Ohashi.
Biology. Forest; ground level; nests in soil
Literature. Eguchi (2001), Ohashi et al. (2017).

Pheidole* cf. *tjibodana Forel, 1905
Collection data. Inoue trail: w & fq, 24.iii.2013, SKY (SR13-SKY-38). 'Lambir': w, 15.v.2011, SKY.

Genus *Strumigenys* F. Smith, 1860
Named Bornean species: 92 (21 in '*Pyramic*a' and 71 in '*Strumigenys*') (Bolton 2000; Pfeiffer et al. 2011). Lambir species: 23 (18 named and 5 unidentified; 2 in '*Pyramica*' and 21 in '*Strumigenys*'). Two species, *S. epyna* and *S. nesterix*, are newly recorded from Borneo. The paucity of dacetine species, especially for

'*Pyramica*', is a remarkable feature of the ant fauna of Lambir. Non-application of Winkler bags may have been partly responsible for this. Most species are forest-floor (ground level) inhabitants, but a few are collected from trees.

Former *Pyramica* Roger, 1862

S. mitis (Brown)-group

Strumigenys mitis (Brown, 2000) (*Pyramica* sp. 14 of SKY) (Pl. 6: 29 [USI: B2356480])

Collection data. 8 ha plot: w, 13.i.1993, honey bait (GN-2-5), SKY. Tourist area: w, 11.viii.1995, T. Itino.

Biology. Forest; ground level; attracted to honey baits; active in night.

Literature. Yamane et al. (1996).

S. capitata (F. Smith)-group

Strumigenys* cf. *themis (Bolton, 2000) (*Pyramica* sp. 13 of SKY)

Collection data. 8 ha plot: w, 6.i.1993; w, 23.i.1993, SKY.

Biology. Forest; ground level.

Former *Strumigenys* F. Smith, 1860

S. akalles Bolton-group

Strumigenys inhonesta Bolton, 2000

Collection data. 'Lambir': w, 18.i.2012, in soil, Y. Maekawa (LL14-29).

Biology. Forest; ground level; ex. soil.

S. doriae Emery-group

Strumigenys doriae Emery, 1887 (sp. 20 of SKY)

Collection data. 8 ha plot: w, 22.i.1993, SKY.

Biology. Forest; ground level.

Strumigenys gloriosa Bolton, 2000 (sp. 7 of SKY)

Collection data. 'Lambir': w, 20.x.2008, M. Yoshima (51-L16).

S. godeffroyi Mayr-group

Strumigenys baal Bolton, 2000 (sp. 54 of SKY)

Collection data. Inoue trail: w, 2.vii.2004, SKY. Sungai Liku: w, 27.vi.2004, decaying wood, SKY.

Biology. Forest; ground level; ex decaying wood.

****Strumigenys epyna*** Bolton, 2000 (sp. 58 of SKY)

Collection data. 'Lambir': w, 14.v.2011, decayed part of live tree, SKY (SR11-SKY-23).

Biology. Forest; a nest found on tree.

Strumigenys hastur Bolton, 2000 (sp. 28 of SKY)

Collection data. 'Lambir': w, 3.viii.1995, H. Okido.

Strumigenys juliae Forel, 1905 (sp. 11 of SKY)

Collection data. 8 ha: w, 1.iii.1997, SKY. 'Lambir': w & wq, 14.v.2011, dead twig, SKY (SR11-SKY-13).

Biology. Forest; ground level; nest in dead twig on ground.

Strumigenys nanzanensis Lin et Wu, 1996 (sp. 1 of SKY, part)

Collection data. 8 ha: w, 26.i.1993, SKY; w, 30.vi.2004, SKY. Tourist area: w, 20.i.1993, SKY. 50 ha plot: w, 27.i.1993, SKY. Bt. Lambir: w, 12.i.1993, SKY. 'Lambir': w, 3.viii.1995, H. Okido.

Biology. Forest; ground level.

****Strumigenys nesteryx*** Bolton, 2000 (sp. 24 of SKY; also sp. 26 of SKY)

Collection data. Tourist area: w, 13.viii.1995, SKY. HQ: w, 10–17.viii.1995, H. Okido.

Biology. Disturbed site (?); ground level.

Strumigenys rofocala Bolton, 2000 (sp. 59 of SKY)

Collection data. 8 ha: w, 18.viii.1997, SKY. 'Lambir': w, 5.viii.2004, HOT (Ground 04-195).

Biology. Forest; ground level.

Strumigenys signeae Forel, 1905 (sp. 5 of SKY; also *sp. 19 of SKY*)

Collection data. 8 ha: w, 3.viii.1995, SKY. 'Lambir': w, 4.viii.1995, Y. Hashimoto.

Strumigenys sublaminata Brown, 1959 (sp. 4 of SKY) (Pl. 6: 30 [USI: B2356481])

Collection data. 8 ha: w, 14.i.1993, SKY. Inoue trail: w & fq, 30.vi.2004, rotting wood, SKY (SR04-SKY-61); w & wq, 2.vii.2004, under bark of log, SKY (SR04-SKY-48); w, 2.vii.2004, ex soil, SKY.

Biology. Forest; ground level; nests in rotting wood and under bark of log; foragers ex soil.

Strumigenys* cf. *tenitecta Bolton, 2000

Collection data. 8 ha: w, 15.viii.1995, ex Araseae, 48 m above ground, T. Yumoto.

Biology. Forest; on tree.

S. konigsbergeri Forel-group

Strumigenys* cf. *amasara Bolton, 2000

Collection data. 'Lambir': w, 15.viii.1995, SKY.

Strumigenys* cf. *blanda Bolton, 2000

Collection data. 8 ha: w, 14.viii.1995, SKY; w, 18.viii.1997, SKY.

Biology. Forest; ground level.

Strumigenys konigsbergeri Forel, 1905 (sp. 15 of SKY)

Collection data. 8 ha: w, 18.viii.1997, SKY.

Biology. Forest; ground level.

Strumigenys naberia Bolton, 2000 (sp. 3 of SKY)

Collection data. 8 ha: w, 15.i.1993, SKY.

S. lyroessa (Roger)-group

Strumigenys aechne Bolton, 2000 (sp. 42 of SKY)

Collection data. 'Lambir': w, 22.x.2008, M. Yoshima (A-L2).

Strumigenys arrogantia Bolton, 2000 (sp. 41 of SKY)

Collection data. Sungai Liku: w, 27.vi.2004, SKY.

Strumigenys* cf. *dryas Bolton, 2000 (sp. 60 of SKY)

Collection data. 'Lambir': w, 18.i.2012, LL14-20.

Strumigenys prosopis Bolton, 2000 (sp. 50 of SKY)

Collection data. 8 ha: w, 3.i.1998, SKY.

Tribe Crematogastrini Forel, 1893

The famous tramp ant *Trichomyrmex destructor* (Jerdon, 1851) (formerly assigned to *Monomorium*) has not been found in Lambir. This species is also absent in the list of Bornean ants by Pfeiffer et al. (2011). We collected it only in Sabah but very rarely (Yamane, personal obs.).

Genus *Acanthomyrmex* Emery, 1893

Named Bornean species: 6 (Moffett 1986; Pfeiffer et al. 2011). Lambir species: 2 (named). *A. ferox* is very common on forest floor.

Acanthomyrmex concavus Moffett, 1986 (sp. 3 of SKY)

Collection data. 8 ha plot: w, 30.i.1993, SKY; w, 30.i.1993, honey bait (G-1-3), SKY. 'Lambir': w, 31.x.2008, M. Yoshima (7-L/5YM686).

Biology. Forest; ground level; attracted to honey baits; active in daytime.

Literature. Yamane et al. (1996).

Acanthomyrmex ferox Emery, 1893 (sp. 1 of SKY) (Pl. 6: 31 [USI: B2356482])

Collection data. 8 ha plot: w, 6–16.i.1993, SKY; w, 13.i.1993, honey bait (G-1-13), SKY; w, 15.i.1993, honey bait (G-3-10), SKY; w & fq, 23–31.i.1993, SKY; w, 31.i.1993, honey bait (T-2-1), SKY; w, 10–16.xii.1993, SKY; 2–24.viii.1995, SKY; w, 30.xii.1997, SKY; w, 3.i.1998, SKY. Tourist area: w, 15.xii.1993, SKY; 24.viii.1995, H. Okido; w & q, 30.xii.1997, SKY. Inoue trail: w & q, 2.vii.2004, leaf litter, SKY (SR04-SKY-43). Bt. Pantu: w, 16.i.1993, SKY.

Sungai Liku: w, 23.iii.2013, leaf litter, SKY. Catchment area: w, 2.viii.1995. 'Lambir': w, 2.i.1998, SKY; w, 19.v.2011, S. Hasin.

Biology. Forest; ground level, foragers also on lower tree trunks; foraging in leaf litter; nests in soil; attracted to honey baits; active in daytime.

Literature. Yamane et al. (1996), Ohashi et al. (2017; CO_2 emission from nests).

Genus *Calyptomyrmex* Emery, 1887

Named Bornean species: 7 (Shattuck 2011); Lambir species: 5 (3 named and 2 unidentified).

Calyptomyrmex danum Shattuck, 2011 (sp. 8 of SKY) (Pl. 7: 32 [USI: B2356483])

Collection data. Canopy 4 ha: 2.vii.2004, ex epiphyte soil, SKY (SR04-SKY-80). 'Lambir': w, vi–viii. 2004, HOT & T. Itioka (AT0270).

Biology. Forest. SR04-SKY-80 was collected from the root system of an epiphyte on tree.

Calyptomyrmex loweri Shattuck, 2011 (sp. 1 of SKY)

Collection data. 8 ha plot: w, 6.i.1993, SKY; w, 18.viii.1997, SKY. Sungai Liku: w, 23.iii.2013, leaf litter, SKY.

Biology. Forest; ground level.

Calyptomyrmex* cf. *rectostriatus Shattuck, 2011 (sp. 3 of SKY)

Collection data. 8 ha plot: w, 10.viii.1995, SKY.

Calyptomyrmex sabahensis Shattuck, 2011 (sp. 5 of SKY)

Collection data. 'Lambir': 10.x.2008, M. Yoshima (61-L4; YM-0274).

Unidentified species in *Calyptomyrmex*: **sp. A** ('Lambir'; LL1-35, in soil).

Genus *Cardiocondyla* Emery, 1869

Named Bornean species: 6 (Pfeiffer et al. 2011); Lambir species: 8 (1 named and 7 unidentified).

Cardiocondyla kagutsuchi Terayama, 1999-complex (sp. 1 of SKY)

Collection data. 8 ha plot: w, 18.iv.1993, SKY. HQ: w, 7.i.1993, SKY. Bt. Lambir: w, 12.i.1993, summit (450 m alt.), SKY.

Taxonomic notes. Although Pfeiffer et al. (2011) recorded *C. kagutsuchi* from Borneo, this species has so far been collected only from Ishigaki-jima, Yaeyama Is., S. Ryukyus, Japan, and a closely related lineage was found in the Malay Peninsula (Okita et al. 2015). The Bornean population might belong to a different unnamed species in the *C. kagutsuchi*-complex.

Cardiocondyla wroughtonii (Forel, 1890) (sp. 2 of SKY)

Collection data. HQ: w, 7.i.1993, SKY. Canopy 4 ha: 8.iii.2004, HOT (P9B8, TY04-355). 'Lambir': w, 3.xi.2010, T. Yamasaki (TY-10-01).

Unidentified species in *Cardiocondyla*: **sp. 3 of SKY** ('Lambir'), **sp. 4 of SKY** (8 ha, tourist area & 'Lambir') (Pl. 7: 33 [USI: B2356484]), **sp. 5 of SKY** (8 ha, tourist area, 50 ha plot, Bt. Lambir & 'Lambir'), **sp. 6 of SKY** (8 ha plot), **sp. 14 of SKY** (8 ha plot), and **sp. 15 of SKY** (Canopy 4 ha; P10B8-2).

Genus *Carebara* Westwood, 1840

Named Bornean species: 4 (4 in '*Pheidologeton*'). Lambir species: 10 (2 named & 8 unidentified; 7 in '*Oligomyrmex*' & 4 in '*Pheidologeton*'). *Oligomyrmex* and *Pheidologeton* were synonymized with *Carebara* by Fernández (2004). *Carebara* ('*Pheidologeton*') *diversa* (Jerdon, 1851), a famous tramp ant, has recently not been found in Borneo (only one old specimen exists at the Natural History Museum, London), though it is very common in the Philippines, Sulawesi, Bali, through Singapore to Indo-china and Sri Lanka (Yamane 2003). Lambir lacks *C.* ('*Pheidologeton*') *silenus* (F. Smith, 1958), a wide-ranging species found in Sundaland area (including Sabah) and Thailand.

Former *Oligomyrmex* Mayr, 1867

Unidentified species in former *Oligomyrmex*: ***O.* sp. 1 of SKY** (8 ha plot, Tourist area, Inoue trail, 50 ha plot & 'Lambir'; nests in rotting wood/sandy soil) (Pl. 8: 35 [USI: B2356486], 36 [USI: B2356487]), ***O.* sp. 2 of SKY** (8 ha plot), ***O.* sp. 5 of SKY** (=*O.* sp. 4 & 9 of SKY; attracted to honey baits at night; GN-1-1; nests in soil; Ohashi et al. 2017, CO_2 emission from nests), ***O.* sp. 11 of SKY** ('Lambir'; ex soil), ***O.* sp. 31 of SKY** (8 ha plot & Inoue trail; nest in soil; Ohashi et al. 2017, CO_2 emission from nests), ***O.* sp. 32 of SKY** ('Lambir', P078), and ***O.* sp. 34 of SKY** ('Lambir', ex soil).

Former *Pheidologeton* Mayr, 1862

Carebara affinis (Jerdon, 1851) (*Pheidologeton* sp. 1 of SKY)

Collection data. 8 ha plot: w, 7.i.1993, SKY; w, 27.viii.1994, T. Itioka & T. Yumoto (#105, 117). HQ: w, 21–25.viii.1995, H. Okido. 50 ha plot: w, 12.i.1993, SKY. 'Lambir': w, 2.iii.1997, SKY.

Taxonomic notes. This species is distinguished from *Carebara* sp. (*Pheidologeton* sp. 5 of SKY) in the pilosity of minor workers (Yamane 2003). The former has more than 6 standing hairs just in front of the posterior margin of the vertex, and 6–7 pairs of standing hairs on the promesonotum, while the latter has only 4 or 5 standing hairs just in front of the posterior margin of the vertex and 5 pairs of standing hairs on the promesonotum. The former prefers forest edges and secondary forests, while the latter is generally confined to primary rainforests.

Biology. Forest edge, sparse forests; ground level; nests in soil.

Literature. Yamane (2003), Ohashi et al. (2017) (nest CO_2 emission).

Carebara pygmaea (Emery, 1887) (*P.* sp. 2 of SKY) (Pl. 9: 38 [USI: B2356489], 39 [USI: B2356490])

Collection data. 8 ha plot: w, 3.iii.1997, SKY. Tourist area: w, 25.i.1993, SKY.

Taxonomic notes. This is unique for '*Pheidologeton*' in having a complete dimorphic worker caste (Pl. 9: 38, 39).

Biology. Forest; ground level. Although this species is similar to '*Oligomyrmex*' in having a complete dimorphism in the worker caste, it has behavior similar to '*Pheidologeton*' in foraging on ground surface in groups.

Literature. Yamane (2003).

Unidentified species in '*Pheidologeton*': ***P.* sp. 5 of SKY** (8 ha plot, Tourist area & 50 ha plot; attracted to cheese baits; Ohashi et al. 2017, CO_2 emission from nests).

Genus *Cataulacus* F. Smith, 1854

Named Bornean species: 6 (Pfeiffer et al. 2011). Lambir species: 6 (5 named and 1 unidentified). *Cataulacus* sp. 4 may be an undescribed species. All the Lambir species seem arboreal, but foragers are frequently collected from lower vegetation close to the ground surface.

Cataulacus hispidulus F. Smith, 1865 (sp. 5 of SKY)

Collection data. 'Lambir': w, 7.ii.2010, HOT (H311.12; CA1091).

Cataulacus horridus F. Smith, 1857 (sp. 1 of SKY) (Pl. 7: 34 [USI: B2356485])

Collection data. 8 ha plot: w, 7–21.i.1993, SKY; w, 16.xii.1993, SKY; w, 27.viii.1994, T. Itioka & T. Yumoto (#66, 85); w, 30.xii.1997, SKY. Tourist area: w, 22.i.1993, SKY. Bt. Pantu: w, 16.i.1993, SKY; w, 1.i.1998, F. Yamane. 50 ha plot: w, 7.i.1993, SKY. Bukit Lambir: w, 12–22.i.1993, SKY. 'Lambir': w, 6.viii.1993, on *Korthalsia rostrata*, T. Itino; w, 16.viii.1997, SKY; w, 27.vii.2001 (CR067); w, 25.iii.2013, E. Yamane.

Biology. Forest; on trees from near ground to canopy; attracted to cheese and honey baits; collecting dead insects.

Literature. Hashimoto et al. (1997), Katayama et al. (2012; as *C. horvidus* sic).

Cataulacus latissimus Emery, 1893 (sp. 3 of SKY)

Collection data. 8 ha plot: w, 23–24.viii.1995, tree tower, SKY; w, 15.viii.1997, tree tower, SKY. Tourist area: w, 13.viii.1995, SKY. 'Lambir': w, 3.vi.2001 (CR004).

Biology. Forest; foragers on trees from close to ground up to canopy; a nest found from canopy; active in daytime.

Literature. Tanaka et al. (2010), Tanaka & Itioka (2012), Katayama et al. (2012).

Cataulacus praetextus F. Smith, 1867 (sp. 2 of SKY)

Collection data. Canopy 4 ha: w, 4.iii.2004, HOT (P3B5-1). 'Lambir': w, v–

vi.2003, HOT (AT0163); fq, xii.2003–iii.2004, HOT & T. Itioka (#DAT394).
Biology. Forest; arboreal.
Literature. Tanaka & Itioka (2012).

Cataulacus reticulatus F. Smith, 1857 (sp. 7 of SKY)

Collection data. 'Lambir': w, vi–viii.2004, HOT & T. Itioka (AT0234); w, 11.ix.2005, HOT (P078, 12; AT1017), w, 29.ix.2006, HOT (A052.11, AT1357).
Biology. Forest; on trees.

Unidentified species in *Cataulacus*: **sp. 4 of SKY** (8 ha plot, Inoue trail & Bt. Lambir; related to *C. horridus*, but very different in body shape and sculpture; Tanaka & Itioka (2012; as *C. insularis*).

Genus *Crematogaster* Lund, 1831

Named Bornean species: 33 (Pfeiffer et al. 2011). Lambir species: 46 (30 named and 16 unidentified). Some of the species were identified by Dr. S. Hosoishi. After careful comparison of more colony series the number of species may be reduced especially for the '*C. rogenhoferi* group'. Two species, *C. ransonneti* and *C. simboloni*, are newly recorded from Borneo.

Subgenus *Crematogaster* Lund, 1831

C. borneensis André-group (=subgen. *Decacrema* Forel, 1910)

The ants of this group are generally obligately associated with *Macaranga* species (Euphorbiaceae) (Pl. 3: 16–18). So far five species have been recorded from Lambir National Park and its vicinity (Feldhaar et al. 2016). In Lambir National Park ant-plant relationships have been studied by Itioka & Itino (1999), Itioka et al. (2000), Itino & Itioka (2001), Itino et al. (2001a, b), Hatada et al. (2001, 2002), Inui et al. (2001), Nomura et al. (2001a, b), Murase et al. (2002, 2003, 2010), Itioka (2005), Inui & Itioka (2007), Ueda et al. (2008, 2015), Handa et al. (2013), Shimizu-kaya et al. (2015, 2016), Shimizu-kaya & Itioka (2016), Quek et al. (2017) and others.

Crematogaster borneensis André, 1896 (sp. 5 of SKY, part) (*captiosa* subgroup)

Collection data. Tourist area: w, 12.viii.1995, T. Itino. 'Lambir': w, xi.1997, ex *Macaranga trachyphylla*, T. Itino (#OKA97-05).
Biology. This species is rather general in its host selection (Feldhaar et al. 2016). In Lambir it was collected from *M. trachyphylla* Airy Shaw.
Literature. Itino & Yamane (1995), Tanaka et al. (2007), Feldhaar et al. (2016).

Crematogaster captiosa Forel, 1911 (*captiosa* subgroup)

Collection data. Tourist area: w, 22.iii.2013, ex *Macaranga trachyphylla*, SKY (SR13-SKY-02); w, 22.iii.2013, ex *M. bancana*, SKY (SR13-SKY-13). Sungai Liku: w, 23.iii.2013, ex *M. hullettii*, SKY (SR13-SKY-16). 'Lambir': w & wq, 8.viii.1994, ex *M. lamellata*, T. Itino (#94-47-1); w & fq, 8.viii.1994, ex *M.*

lamellata, T. Itino (#94-49-1).

Biology. In Lambir, this species has been collected from four species of *Macaranga*, all belonging to the section *Pachystemon*.

Crematogaster decamera Forel, 1910 (*decamera* subgroup)

Collection data. 8 ha plot: w, 4.i.2001, ex *Macaranga hypoleuca*, A. Hatada (AH-LM-56). Tourist area: w, 29.xii.2000, ex *M. hypoleuca*, A. Hatada (AH-LM-48): w, 22.iii.2013, ex *Macaranga hypoleuca*, SKY (SR13-SKY-03). Sungai Liku: w, 22.xii.2000, ex *M. hypoleuca*, A. Hatada (AH-LM-40); w, 6.i.2001, ex *M. hypoleuca*, A. Hatada (AH-LM-28).

Biology. Feldhaar et al. (2016) recorded this species from five species of the section *Pachystemon* of *Macaranga*. In Lambir we collected it from *M. hypoleuca* of the same section.

Literature. Murase et al. (2010), Feldhaar et al. (2016).

Crematogaster hullettii Feldhaar, Maschwitz et Fiala, 2016 (*decamera* subgroup)

Collection data. Tourist area: 28.xii.2000, ex *Macaranga kingii* [*M. umbrosa*], A. Hatada (AH-LM-23).

Literature. Feldhaar et al. (2016).

Crematogaster linsenmairi Feldhaar, Maschwitz et Fiala, 2016 (*captiosa* subgroup)

Collection data. Tourist area: w, 14.viii.1995, T. Itino (#111). Sungai Liku: w, 23.iii.2013, ex *Macaranga rufescens*, SKY (SR13-SKY-19); w, 23.iii.2013, ex *M. hosei*, SKY (SR13-SKY-20); w, 23.iii.2013, ex *M. umbrosa*, SKY (SR13-SKY-23).

Biology. Three *Macaranga* species are partner plants of this ant in Lambir.

Literature. Feldhaar et al. (2016).

Crematogaster maryatiae Feldhaar, Maschwitz et Fiala, 2016 (*maryatiae* subgroup)

Collection data. Tourist area: 15.xii.2000, ex *Macaranga kingii* [*M. umbrosa*], A. Hatada (AH-LM-35). Bt. Pantu: w, 23.iii.2013, ex *M. havilandii*, SKY (SR13-SKY-26).

Biology. The partner species *M. havilandii* and *M. umbrosa* belong to the waxy section *Pachystemon*.

C. brevis Emery-complex (=subgen. *Mesocrema* Santschi, 1928)

Crematogaster treubi Emery, 1896 (sp. 10 of SKY; also *sp. 21, 47, 54 of SKY*)

Collection data. 8 ha plot: w, 6.i.1993, SKY; w, 30.i.1993, sugar bait (T-1-9), SKY; w, 25.viii.1993, sugar bait, T. Itino; w, 30.viii.1993, sugar bait, 35 m above ground; 26–27.viii.1994, T. Itioka & T. Yumoto (Nos. 17, 89); w, 15.viii.1995, ex epiphyte, 48 m above ground, T. Yumoto; w, 23–24.viii.1995, Tower2 to walkways, SKY. Tourist area: 15.viii.1997, at night, SKY. 'Lambir': w, 5.vi.2001 (CR019); w, 25.viii.2003, HOT (BTA053); w, 7.iii.2004, HOT (P7B5-1); w,

8.iii.2004, HOT (P10-B3); w & wq, 20.ix.2006, Ww6-3, HOT (AT1269); w, 28.i.2010, T1,13, HOT (CA1007); w, 29.i.2010, Tw, 29, HOT (CA1029).

Biology. Very common species mainly seen on tree trunks; frequently attracted to sugar baits; active in daytime, but also collected at night (1 case).

Literature. Yamane et al. (1996; as *C*. sp. 3), Tanaka et al. (2007), Hosoishi & Ogata (2012).

C. brunnea F. Smith-group (part of *Crematogaster* s. str.)

Crematogaster brunnea F. Smith, 1857 (sp. 25 of SKY)

Collection data. 'Lambir': w, v–vi. 2003, HOT & T. Itioka (ATO146); w, 31,i.2010, Tw 3.6, HOT (CA1054).

Literature. Tanaka & Itioka (2012).

Unidentified species in the *C. brunnea* group: **sp. 104 of SKY** (= *sp. 111 of SKY*) (Canopy 4 ha & 'Lambir', AT074, 0539).

C. coriaria Mayr-group (=subgen. *Paracrema* Santschi, 1918)

This is an informal group including two very common Bornean species that share the 4-segmented antennal club. These two species were assigned to the *C. inflata*-group by Blaimer (2012).

Crematogaster coriaria Mayr, 1872 (sp. 87 of SKY)

Collection data. 8 ha plot: w, 26.viii.1994, T. Itioka & T. Yumoto (#1, 7). Canopy 4 ha: 4.iii.2004, HOT (P3B15-1; TY04-160). Tourist area: w, 30.vi.2004, leaf litter, SKY. 50 ha plot: 27.i.1993, SKY. 'Lambir': w, 18.viii.1995, at night, H. Okido; w, 3–12.ix.2009 (ant-mimic sample 214); w, 9.ii.2010, HOT (H261.8); w, 13.ii.2010, next to tree tower 6, HOT.

Taxonomic notes. The type species of the subgenus *Paracrema* is *C. spengeri* Forel, 1912 from Sumatra, which, however, is a junior synonym of *C. coriaria* (cf. Hosoishi & Ogata 2015). We have several small workers that closely agree with the original description of *C. spengeri* in having a very shiny body surface; posterior 2/3 of head dorsum and pro-mesonotal dorsum smooth and shiny, and propodeal dorsum with very weakly sculptured surface and shiny. However, body sculpture is generally weaker in smaller specimens in *Crematogaster* species, and often useless in separating species (but one large worker at hand has a very shiny body).

Biology. Forest; ground level and on trees; prey of *Aenictus laeviceps* (F. Smith, 1857).

Literature. Tanaka & Itioka (2012), Hashimoto & Yamane (2014), Hosoishi & Ogata (2015).

Crematogaster modiglianii Emery, 1900 (sp. 19 of SKY) (Pl. 9: 40 [USI: B2356491])

Collection data. 8 ha plot: w, 6.i.1993, SKY; w, 3.i.1998, F. Yamane; w, 5.xii.2000, nest in tree hollow, A. Hatada (AH-LM-09); w, 4.xi.2001, on walkway, foraging with *Camponotus irritabilis*, A. Hatada; w, 30.vi.2004, night, SKY. Tourist area: w, 20.i.1993, 25.i.1993, SKY; w, 15.viii.1997, at night, SKY; SKY; w, 30.xii.1997, with *Camponotus rufifemur*, SKY (SR97-SKY-109); w, 31.xii.1997, SKY; w, 12.xii.2000, flower nectar, A. Hatada (AH-LM-59); w, 27.vi.2004, nest in tree trunk, SKY (SR04-SKY-84). HQ: 15–17.viii.1995, SKY. Bt. Pantu: w, 16.i.1993, SKY. Sungai Liku: w, 13.xi.2000, attending seeds of *M. praestans*, A, Hatada; w, 3.xii.2000, on *M. gigantea*, A. Hatada (AH-LM-04, -42); w, 3.xii.2000, EFN of *Scaphium*, A. Hatada (AH-LM-53); w, 3.xii.2000, EFN of *Shorea macrophylla*, A. Hatada (AH-LM-53); w, 8.xii.2000, ex *M. lamellata*, A. Hatada (AH-LM-30); w, 27.vii.2004, ex *M. bancana*, SKY. 'Lambir': w, 31.xii.1997, ex *M. trachyphylla*, SKY (SR97-SKY-02); w, 31.xii.1997, ex *M. hullettii*, SKY (SR97-SKY-03).

Biology. Forest and forest edge; ground level and on trees; nests in tree hollows; attracted to cheese baits, and *Endospermum*, *Scaphium* and *Shorea* extrafloral nectaries; active day and night. This most dominant acrobat ant shares foraging trails with *Camponotus* (*Myrmotarsus*) *irritabilis* (F. Smith, 1857) and *C*. (*M*.) *rufifemur* Emery (1900), and often takes over *C. borneensis*-group nests in *Macaranga* stems.

Literature. Hosoishi et al. (2011).

C. cylindriceps Wheeler-group (=subgen *Colobocrema* Wheeler, 1927) (Pl. 10: 41, 42)

Crematogaster* cf. *cylindriceps Wheeler, 1927 (sp. 103 of SKY) (Pl. 10: 41 [USI: B2356492], 42 [USI: B2356493])

Collection data. 8 ha plot: w & fq, 26.ix.2005, walkway, HOT (HYT015). LUBL F4: w, 26.vi.2004, nest in live climber plant, SKY (SR04-SKY-01); w, q &m, same date, nest in live climber, SKY (SR04-SKY-04). 'Lambir': fq, 29.viii.2003, HOT.

Taxonomic notes. We compared the queens of this species with the type (queen) of *C. cylindriceps* (head missing) and also with the original description, but could not find any important difference between them. We need worker specimens from the type locality, the Philippines, to determine the correct status of our species.

Biology. Primary and secondary forests; arboreal. The species nests in a climber plant, *Spatholobus* sp., of the bean family (Fabaceae) from the ground level to the subcanopy up to 24 m above ground. Colonies are polygynous. This species is found often with *Cladomyrma hobbyi* Donisthorp, 1937 in the secondary forest, and with *Tetraponera inversinodis* Ward, 2001 and *T. pilosa* F. Smith, 1858 in

the subcanopy of the 8 ha plot, in the same plants but from different nodes.
Literature. Yamane et al. (2011).

C. fraxatrix Forel-group (part of *Crematogaster* s. str.)

Crematogaster fraxatrix Forel, 1911 (sp. 7 of SKY)

Collection data. 8 ha plot: w, 7.i.1993, SKY; w, 30.i.1993, honey bait (daytime), SKY. 'Lambir': 24.ix.2006, HOT (I083-2, 5-7, 8; AT1313, 1317, 1323).
Biology. Forest, ground level; attracted to honey baits.
Literature. Hosoishi & Ogata (2014).

****Crematogaster ransonneti*** Mayr, 1868 (sp. 48 of SKY)

Collection data. 8 ha plot: w, 27.viii.1994, T. Itioka & T. Yumoto (#67). 'Lambir': w, 26.xi.2000, Y. Kumano (YK-w6-0-0-7); w, 11.viii.2001 (CR077); w, v-vi.2003, HOT & T. Itioka (AT0148, 0171); w & m, 4.viii.2004, HOT (P8B14-1); w, 2.ii.2010, HOT (Tw6.5; CA1067); w, 4.ii.2010, HOT (Tw6.5; CA1062); w, 6.ii.2010, HOT.
Biology. Forest; lower vegetation and canopy; active day and night. Nests are in large branches on trees.
Literature. Tanaka et al. (2010).

****Crematogaster simboloni*** Hosoishi et Ogata, 2014 (sp. 39 of SKY)

Collection data. Canopy 4 ha: w, 7.iii.2004, HOT (P7B15). 'Lambir': w, 21.i.2003, T. Matsumoto (BOTY500C); w, 26.ix.2006, HOT; w, 17.ii.2010, Ww11-5, HOT (CA1186).
Biology. Forest; arboreal. Nests are found in large branches on trees.

Unidentified species in *Crematogaster fraxatrix* group: **sp. 14 of SKY** (8 ha plot; 1 colony ex *Myrmecodia*).

C. inflata F. Smith-group (=subgen. *Physocrema* Forel, 1912)

This group is Asian endemic and currently comprises 12 species from tropical and subtropical areas (Hosoishi & Ogata 2009). From Lambir we recognize five species, of which one, *C. difformis* F. Smith, 1857, nests in epiphytes in the canopy (Tanaka et al. 2010).

Crematogaster difformis F. Smith, 1857 (sp. 1 of SKY; also sp. 4 of SKY) (Pl. 1: 5–7)

Collection data. 8 ha plot: w, 14.i.1993, SKY; w, 19.iv.1993, walkway, SKY; w, 17.viii.1995, ex epiphyte, T. Yumoto; w, 18.viii.1995, ex epiphyte with cockroaches, SKY; w, 30.xii.1997, walkway, F. Yamane; 26.xi.2000, walkway, on *Shorea smithiana*, Y. Kumano (YK-w9-0-0-6). 50 ha plot: w, 7.i.1993, SKY. 'Lambir': w, 28.ix.2005, ex epiphyte (colony from which the type of *Crematogaster tanakai* was collected), HOT.
Taxonomic notes. The more common *C. sewardi* Forel, 1901 had been confused with *C. difformis* until Hosoishi & Ogata (2008) raised the status of *sewardi* to

species from a subspecies of *C. difformis* (frequently misspelled as *deformis* or *diformis*; see Bolton 1995). Although *C. sewardi* is common in Borneo, Java, Sumatra and Malay Peninsula, we have not seen it in Lambir.

Biology. Forest; foragers in lower vegetation to canopy; active day and night. This ant nests in large domatia of epiphyte ferns, *Platycerium ridleyi* H. Christ and *Lecanopteris crustacea* Copel. (Tanaka & Itioka 2011, 2012), living with a specialized cockroach, *Pseudoanaplectinia yumotoi* Ross, 1995 (Ross 1995; Inui et al. 2009), a myrmecophilous aphodiine beetle, *Pterobius itiokai* Maruyama, 2010 (Maruyama 2010), a myrmecophilous brentid beetle, *Pycnotarsobrentus inuiae* Maruyama & Bartolozzi, 2014 (Maruyama et al. 2014). This ant regulates the distribution of other ant species and lianas on emergent trees (Tanaka & Itioka 2011, 2012).

Literature. Itino & Yamane (1995; as sp. 4 of SKY), Ross (1995) (associated cockroach), Yamane et al. (1996; as *C. deformis*), Hosoishi & Ogata (2008, 2009), Inui et al. (2009) (association with cockroach), Tanaka et al. (2009, 2010) (anti-herbivore effects), Maruyama (2010) (associated myrmecophilous aphodiine beetle), Hyodo et al. (2011) (feeding habits), Tanaka & Itioka (2011, 2012) (regulation of the distribution of ants and lianas), Katayama et al. (2012), Maruyama et al. (2014) (associated myrmecophilous brentid beetle).

Crematogaster inflata F. Smith, 1857 (sp. 94 of SKY) (Pl. 2: 13; Pl. 10: 43 [USI: B2356494])

Collection data. 8 ha plot: w, 3.i.1998, SKY. Tourist area: w, 19.viii.1997, SKY; w, 27.vi.2004, at night, SKY (SR04-SKY-17). Inoue trail: 12.v.2011, foragers on ground, SKY (SR11-SKY-07). 'Lambir': w, 14.vii.1998, H. Arakawa; w, 10.v.2011, S. Hasin.

Biology. Forest edge; ground level to lower vegetation; attracted to honey and cheese baits, and dead insects (Hashimoto et al., 1997). The species nests in living tree trunks, collects wood chips for unknown purpose. A mimic formicine ant, *Camponotus* sp., is found around the nest of *C. inflata*.

Literature. Hashimoto et al. (1997), Hosoishi & Ogata (2009), Katayama et al. (2012).

Crematogaster onusta Stizz, 1925 (sp. 67 of SKY)

Collection data. 8 ha plot: w, 30.i.1993, SKY. Tourist area: w, 23.viii.1995, H. Okido. Bt. Pantu: w, 13.viii.1995, SKY. Canopy 4 ha: w, 5.iii.2004, HOT (P5B3). 50 ha plot: w, 7.i.1993, SKY. Sungai Liku: w, 8.xii.2000, on liana, A. Hatada (AH-LM-32).

Biology. Forest; lower vegetation to arboreal. The species nests in large branches on trees.

Literature. Tanaka et al. (2010).

Crematogaster tanakai Hosoishi et Ogata, 2009 (sp. 128 of SKY)

Collection data. 8 ha plot: w & m, 28.ix.2005, in *C. difformis* nest, HOT.

Biology. Forest; canopy. This peculiar-shaped species lives in the colony of *C. difformis* F. Smith, 1857.

Literature. Hosoishi & Ogata (2009).

Crematogaster vacca Forel, 1911 (sp. 2 of SKY)

Collection data. Tourist area: w, 22.i.1993, SKY. 'Lambir': w, 12.viii.1997, Y. Hashimoto; w, 3–12.ix.2009 (ant-mimic sample #252).

Biology. Forest; lower vegetation; attracted to sugar baits.

Literature. Yamane et al. (1996), Hosoishi & Ogata (2009).

C. ranavalonae Forel-group (=subgen. *Oxygyne* Forel, 1901)

Crematogaster daisyi Forel, 1901 (sp. 15 of SKY)

Collection data. 8 ha plot: w, 15.i.1993, SKY. Bt. Pantu: w, 2.i.1998, F. Yamane. Sungai Nikau: w, 10.xii.2000, foragers on forest floor, A. Hatada (AH-LM-19). 'Lambir': w, 16.viii.1997, SKY; w, 2.i.1998, SKY; w, 25.iv.2005, prey of army ant (morning).

Biology. Forest, ground level; hunted by army ants.

Literature. Tanaka et al. (2007; as sp. 84 of SKY), Hosoishi (2015).

Crematogaster imperfecta Hosoishi, 2015 (sp. 83 of SKY)

Collection data. 8 ha plot: w, 26.i.1993, SKY. 'Lambir': w, 9.ii.2010, HOT (H261, 6-7; CA1132).

Biology. Forest; on trees. Nests are in the cavity formed by combined leaves.

Literature. Hosoishi (2015).

Crematogaster tumidula Emery, 1900 (sp. 12 of SKY)

Collection data. 8 ha plot: w, 21.i.1993, SKY. Tourist area: w, 30.xii.1997, SKY (SR97-SKY-106). Bt. Pantu: w, 13.viii.1995, SKY. 'Lambir': w, 16.viii.1997, SKY.

Biology. Forest; ground level.

Literature. Hosoishi (2015).

Unidentified species in *Crematogaster ranavalonae*-group: **sp. 31 of SKY** (8 ha plot, tree tower; Tanaka et al. 2007, as sp. 52 of SKY); **sp. 113 of SKY** (8 ha plot, collected on walkways; Tanaka et al. 2010).

C. rogenhoferi Mayr-group (part of *Crematogaster* s. str.)

Crematogaster rogenhoferi Mayr, 1879 (sp. 9 of SKY)

Collection data. HQ: w, 3–20.viii.1995, SKY. Tourist area: w, 13.viii.1995, SKY.

Biology. Forest edge and disturbed area.

Unidentified species in *C. rogenhoferi* group (?): **sp. 16 of SKY** (Tourist area;

'Lambir', CR054), **sp. 20 of SKY** (=*sp. 26 of SKY*; 8 ha plot; on *Korthalsia hispida*; prey of *Aenictus*; Tanaka et al. 2007, as *sp. 26 of SKY*; Tanaka et al. 2010, nests in crown, upper tree trunk & near ground; Tanaka & Itioka 2012), **sp. 38 of SKY** (Tourist area, Canopy 4 ha; Tanaka et al., 2010, as sp. 30 of SKY), **sp. 49 of SKY** (8 ha plot; 'Lambir', AT1292, CA1106), **sp. 50 of SKY** (8 ha plot, sugar baits, nest in dead twig; 'Lambir', HOTCA-06, 10), **sp. cf 61 of SKY** (Canopy 4 ha), **sp. 147 of SKY** (Canopy 4 ha, AT0272).

Taxonomic notes. These are here tentatively grouped together. All of them have a relatively to very wide petiole and a distinctly bilobed postpetiole. Some should be distinct species, but others are very similar to each other with minor differences. Although in *C. rogenhoferi* the head and mesosoma are almost entirely sculptured and mat, in the above-mentioned species the head and the side of the pronotum are generally smooth and the dorsum of the mesosoma is only weakly sculptured.

Unidentified species in species groups not determined (*Crematogaster* s. str.): **sp. 32 of SKY** (8 ha plot, 'Lambir'; ex. *Macaranga winkleri*; OKA#97-56, -121), **sp. 112 of SKY** (Canopy 4 ha; Tanaka et al. 2007), **sp. 144 of SKY** (Tourist area; ex. *M. winkleri*; SR13-SKY-01, -09).

Taxonomic notes. All these have 11-segmented antennae, 2- or weakly 3-segmented antennal clubs, very short thick propodeal spines, postpetiole almost without a median furrow. *Crematogaster* sp. 32 and sp. 144 live in *Macaranga winkleri* stems, probably replacing *C. borneensis*-group ant colonies. These two are very similar to each other, but the former has lighter ground color (light brown) and weaker body sculpture (mesopleuron partly smooth) than the latter (body color dark brown, mesopleuron entirely sculptured). In the queen of *C*. sp. 32 the gaster is entirely orange yellow. *Crematogaster* sp. 112 worker is entirely black and has a very shiny body.

Subgenus *Orthocrema* Santschi, 1918 (*Orthocrema* + *Rhachiocrema*)

Rhachiocrema consists of several species with very long propodeal spines. It was synonymized with *Orthocrema* by Blaimer (2012).

C. baduvi Forel-group (*Rhachiocrema* Mann, 1919)

Crematogaster baduvi Forel, 1912 (sp. 23 of SKY)

Collection data. 'Lambir'; w, 4–6.vi.2001 (CR002, 024).

Biology. Forest; upper trunks of canopy trees. Nests are in large branches on trees.

Literature. Tanaka et al. (2010).

Crematogaster brunensis Hosoishi et Ogata, 2016 (sp. 132 of SKY)

Collection data. 'Lambir': w, 24.ix.2006, HOT (HOTCA06-0518); w, 21–

27.ii.2009 (ant-mimic sample: 09F137-1); w, 8.ii.2010, HOT (1083.12, CA1123).
Biology. Forest; lower vegetation to canopy. Nests are made in cavities in aerial soil accumulated at branch forks of trees.

C. binghamii Forel-group (part of *Orthocrema* s. str.)

Crematogaster longipilosa Forel, 1907 (sp. 119 of SKY)

Collection data. 8 ha plot: w, 18.iv. 1993, SKY. HQ: 12–13.vii.1996, Y. Hashimoto. 'Lambir': w, 8.ix.2003, HOT (LUB03-07142; BTA1121).
Taxonomic notes. Although Hosoishi & Ogata (2016) did not include Borneo in the distribution range of this species, Wheeler (1919) had already recorded it from Sarawak.
Biology. Forest and forest edge; ground level.

Unidentified species in *C. binghamii*-group: **sp. 53 of SKY** (8 ha plot, Tourist area & 50 ha plot; ground level).

C. biroi Mayr-group (part of *Orthocrema* s. str.)

Crematogaster fritzi Emery, 1901 (sp. 62 of SKY)

Collection data. 8 ha plot: w, 30.viii.1993, sugar bait, T. Itino; w, 15.viii.1995, 48 m above ground, ex epiphyte, T. Yumoto. Canopy 4 ha: w, 8.iii.2004, HOT (P10B8-1). 'Lambir': w, v–vi.2003, HOT & T. Itioka (AT090); w, 26.ix.2006, HOT (AT1340); w, 2.x.2006, HOT (AT1505).
Biology. Forest; arboreal up to canopy; attracted to sugar baits.
Literature. Itino & Yamane (1995; as *C. biroi* var. *bandarensis*).

Crematogaster masukoi Hosoishi, Yamane et Ogata, 2010 (sp. 24 of SKY)

Collection data. 8 ha plot: w, 3.viii.1995, SKY. Tourist area: w, 1.iii.1997, SKY. 50 ha plot: 22.viii.1995, SKY.
Biology. Forest; ground level.
Literature. Hosoishi et al. (2010).

Crematogaster reticulata Hosoishi, 2009 (sp. 93 of SKY)

Collection data. 'Lambir': w, 19.x.2005, C. Handa (CH0514; 33-5); w, 21–27.ii.2009 (ant-mimic sample: 09F126); w, 15.v.2011, palm leaf base; SKY (SR11-SKY-27).
Biology. Forest; ground level to lower vegetation. A nest was found from the leaf base of a palm.
Literature. Hosoishi (2009), Hosoishi & Ogata (2016).

C. quadriruga Forel-group (part of *Orthocrema* s. str.)

Crematogaster bandarensis Forel, 1913 (sp. 52 of SKY; also *sp. 13(b) of SKY*)

Collection data. 8 ha plot: w, 30.i.1993, SKY; w, 27.viii.1994, T. Itioka & T. Yumoto (#117); w, 14.v.2011, attracted to cheese bait, nest in soil, SKY

(SR11-SKY-11). Tourist area: w, 22.i.1993, SKY. Inoue trail: w, 2.vii.2004, rotting wood, SKY (SR04-SKY-78). 'Lambir': w, 8.vii.2010, ex soil, M. Ohashi (LL2-34; A2); w, 9.vii.2010, ex soil, Y. Maekawa (LL2-5; A1).

Biology. Forest; ground level and subcanopy; attracted to cheese baits. This species nests in soil and rotting wood at ground level, and under bark of large trees.

Literature. Tanaka et al. (2007, 2010), Hosoishi & Ogata (2016).

Crematogaster myops Forel, 1911 (sp. 13 of SKY)

Collection data. 8 ha plot: w, 15.i.1993, SKY; w, 23.i.2993, SKY; w, 3.viii.1995, SKY. Tourist area: w, 30.vi.2004, SKY. 'Lambir': w, 10.viii.1995, H. Okido; w, 16.vii.2010, ex soil, Y. Maekawa (L14-6; A1).

Biology. Forest; ground level; in soil.

Literature. Hosoishi & Ogata (2016).

Unidentified species in *C. quadriruga*-group: **sp. 134 of SKY** (cf. *myops*) (8 ha plot, tree tower).

Genus *Dacetinops* Brown et Wilson, 1957

Named Bornean species: 3 (Taylor 1985; Pfeiffer et al. 2011). Lambir species: 2 (named).

Dacetinops cirrosus Taylor, 1985 (sp. 1 of SKY) (Pl. 8: 37 [USI: B2356488])

Collection data. Inoue trail: w, 2.vii.2004, rotting wood, SKY (SR04-SKY-45).

Biology. Forest; ground level; nest in rotting wood.

Dacetinops concinnus Taylor, 1965 (sp. 2 of SKY)

Collection data. 8 ha plot: w, 30.i.1993, SKY.

Genus *Dilobocondyla* Santschi, 1910

Named Bornean species: 2 (Pfeiffer et al. 2011). Lambir species: 3 (1 named, 2 unidentified).

Dilobocondyla borneensis Wheeler, 1916 (sp. 1 of SKY)

Collection data. 'Lambir': w, 7.ii.2010, HOT (H311.9, CA1107).

Unidentified species in *Dilobocondyla*: **sp. 3 of SKY** ('Lambir'; Malaise trap), **sp. 5 of SKY** (8 ha plot, ex epiphyte at 48 m above ground; 'Lambir', P075, Top, AT1376) (Pl. 11: 44 [USI: B2356495]).

Genus *Gauromyrmex* Menozzi, 1933

Named Bornean species: 0. Lambir species 2 (unidentified). This genus, included in *Vollenhovia* until recently, has not been revised, leaving some new forms from Southeast Asia. One species from Sabah constructs nests in resin on tree trunks (Brühl 2003).

Gauromyrmex* cf. *acanthinus (Karavaiev, 1935) (sp. 5 of SKY)

Collection data. 8 ha plot: w, 26.viii.1994, T. Itioka & T. Yumoto (Nos. 11–13, 27–29); xii.2003–iii.2004, tree tower, HOT & T. Itioka.

Biology. Forest; arboreal. Probably nests are constructed under bark of tall trees.

Gauromyrmex* cf. *bengakalisi Menozzi, 1933 (sp. 1 of SKY) (Pl. 11: 45 [USI: B2356496])

Collection data. 8 ha plot: w, 19.iv.1993, walkway, SKY; w, 27.viii.1994, T. Itioka & T. Yumoto (Nos. 78, 90); w, 17.viii.1995, ex epiphyte, SKY; w, 23–24.viii.1995, tree tower–walkway, SKY; w, 30.xii.1997, walkway, SKY; w, xii.2003–iii.2004, walkway, HOT & T. Itioka. Canopy 4 ha: w, 4.iii.2004, HOT (P3B2-1). 'Lambir': w, 6.vi.2001 (CR021); w, v–vi.2003, HOT & T. Itioka (#HT03-0121).

Biology. Forest; arboreal. Workers were collected from trunks of tall trees and epiphytes.

Genus *Lophomyrmex* Emery, 1892

Named Bornean species: 2 (Rigato 1994; Pfeiffer et al. 2011); Lambir species: 1 (named). In Lambir only one species, *L. longicornis*, occurs, although the other species *L. bedoti* Emery, 1893 is often sympatric with the former in some sites in Sabah.

Lophomyrmex longicornis Rigato, 1994 (sp. 1 of SKY) (Pl. 11: 46 [USI: B2356497])

Collection data. 8 ha plot: w, 20.i.1993, honey bait (GN-3-2), SKY; w, 30.i.1993, SKY. Tourist area: w, 2.iii.1993, SKY; w, 30.xii.1997, SKY. Bt. Pantu: w, 2.i.1998, F. Yamane. 'Lambir': w, 23.vi.1998, K. Eguchi (Eg98-BOR-823).

Biology. Forest and forest edge; ground level; nests in soil; attracted to honey baits and cheese baits; visiting *Endospermum* extrafloral nectaries; prey of *Aenictus laeviceps* (F. Smith, 1857); active day and night. This is one of the most common ants in Lambir, foraging in leaf litter and on ground surface.

Literature. Yamane et al. (1996) Tanaka et al. (2010), Hashimoto & Yamane (2014), Ohashi et al. (2017) (nest CO_2 emission).

Genus *Lordomyrma* Emery 1897

Named Bornean species: 1 (Lucky & Sarnat 2008; Pfeiffer et al. 2011); Lambir species: 2 (unidentified).

Unidentified species in *Lordomyrma*: **sp. 3 of SKY** (8 ha plot and Sungai Liku; nest under stone), **sp. 8 of SKY** ('Lambir', AT0474).

Genus *Mayriella* Forel, 1902
Named Bornean species: 1 (Pfeiffer et al. 2011). Lambir species: 1 (named).

Mayriella transfuga Baroni Urbani, 1977
Collection data. 'Lambir': w, 4.viii.2004, HOT (#Ground 04-322).
Biology. Forest; ground level.

Genus *Meranoplus* F. Smith, 1854
Named Bornean species: 6 (Schödl 1998; Pfeiffer et al. 2011); Lambir species: 2 (named). Pfeiffer et al. (2011) recorded *M. bicolor* (Guérin-Méneville, 1844) from Borneo, citing Schödl (1998). However, we did not find any record of this species from Borneo in Schödl (1998). The named species from Borneo should be reduced to 5.

Meranoplus castaneus F. Smith, 1857 (sp. 2 of SKY) (Pl. 12: 47 [USI: B2356498])
Collection data. 8 ha plot: w, 31.i.1993, honey bait (T-3-14), SKY; w, 19.iv.1993, walkway, SKY; w, 30.viii.1993, on dipterocarp tree (25 m high), sugar bait, T. Itino; w, 16.xii.1993, SKY; w, 26-27.1994, T. Itioka & T. Yumoto (#38, 81); w, 23-24.viii.1995, tree tower–walkway, SKY; w, 3.iii.1997, tree tower–walkway, SKY; w, 15.viii.1997, tree tower, SKY; w, 30.xii.1997, walkway, SKY. HQ: fq, 21–25.viii.1995, H. Okido. Bt. Pantu: w, 16.i.1993, SKY. 'Lambir': w, 5.vi.2001 (CR010); wq, xii.2003–iii.2004, HOT (DAT 157).
Biology. Forest; arboreal; nests on trees; attracted to sugar/honey baits; active day and night.
Literature. Itino & Yamane (1995), Yamane et al. (1996), Schödl (1998), Tanaka & Itioka (2012).

Meranoplus malaysianus Schödl, 1998 (sp. 1 of SKY)
Collection data. 8 ha plot: w, 11–16.i.1993, SKY; w, 12.i.1993, honey bait (GN-1-11), SKY.
Biology. Forest; ground level; attracted to honey baits; active at night.
Literature. Yamane et al. (1996).

Genus *Myrmecina* Curtis, 1829
Named Bornean species: 1 (Pfeiffer et al. 2011). Lambir species: 4 (all unidentified).

Myrmecina* cf. *bandarensis Forel, 1913 (sp. 2 of SKY) (Pl. 12: 48 [USI: B2356499])
Collection data. 8 ha plot: w, fq, wq & m, 6–26.i.1993, SKY; w, 18.iv.1993, SKY; w, 27.viii.1994, T. Itioka & T. Yumoto (#113); w, fq, wq & m, rotting wood, SKY (SR04-SKY-49). Tourist area: w, 15.xii.1993, SKY. 50 ha plot: w, 27.i.1993, SKY.
Biology. Forest; ground level; nest in rotting wood.

Unidentified species in *Myrmecina*: **sp. 1 of SKY** (8 ha plot, Tourist area, 50 ha plot & 'Lambir'; ground level; nests in soil; attracted to cheese baits), **sp. 3 of SKY** (8 ha plot), **sp. 13 of SKY** (8 ha plot).

Genus *Pristomyrmex* Mayr, 1866
Named Bornean species: 11 (Wang 2003; Pfeiffer et al. 2011); Lambir species: 4 (3 named, 1 unidentified).

Pristomyrmex bicolor Emery, 1900 (sp. 1 of SKY)

Collection data. 8 ha plot: w, 6–20.i.1993, SKY; w, 3.iii.1997, SKY. Tourist area: 20–22.i.1993, SKY. Inoue trail: w, 24.iii.2013, SKY.

Taxonomic notes. As mentioned by Wang (2003) this species is highly variable in sculpture and length of pronotal spines. The syntypes are bicolorous with dark brown heads, mesosomas and waists, and ferruginous legs and gasters (Emery 1900), but specimens from Borneo have unicolorously orange bodies with slightly yellowish gasters.

Biology. Forest; ground level; collected from large decaying wood.

Pristomyrmex costatus Wang, 2003 (sp. 2 of SKY) (Pl. 12: 49 [USI: B2356500])

Collection data. 8 ha plot: w, 10.viii.1995, SKY; w, 3.viii.1995, SKY. Tourist area: w, 22.i.1993, SKY. Bt. Pantu: w, 16.i.1993, SKY. 50 ha plot: w, 12.i.1993, SKY. Bt. Lambir: w, 22.viii.1995, SKY.

Biology. Forest; ground level; attracted to honey baits; active in daytime.

Literature. Yamane et al. (1996).

Pristomyrmex trachylissus (F. Smith, 1858) (sp. 14 of SKY)

Collection data. Tourist area: w, 2.iii.1997, SKY.

Biology. Forest; ground level.

Unidentified species in *Pristomyrmex*: **sp. 7 of SKY** (8 ha plot).

Genus *Proatta* Forel, 1912
Named Bornean species: 1 (Pfeiffer et al. 2011). Lambir species: 1 (named).

Proatta butteli Forel, 1912 (sp. 1 of SKY) (Pl. 13: 50 [USI: B2356501])

Collection data. 8 ha plot: w & fq, 16.i.1993, SKY.

Biology. Forest; ground level.

Genus *Recurvidris* Bolton, 1992
Named Bornean species: 2 (Bolton 1992; Pfeiffer et al. 2011); Lambir species: 3 (2 named & 1 unidentified).

Recurvidris browni Bolton, 1992 (sp. 4 of SKY) (Pl. 13: 51 [USI: B2356502])

Collection data. 8 ha plot: w, 7.i.1993, SKY; w, 30.xii.1997, SKY. Tourist area:

w, 30.vi.2004, in soil, SKY (SR04-SKY-30). Bt. Pantu: w, 13.viii.1995, SKY. 'Lambir': w, 7.xi.2008, M. Yoshima (W1-L17/YM-1251; identified as sp. 8 of SKY).

Biology. Forest; ground level; nests in soil.

Recurvidris kemneri (G. C. Wheeler et J. Wheeler, 1954) (sp. 3 of SKY)

Collection data. Tourist area: w, 7.i.1993, SKY. 50 ha plot: w, 27.i.1993, SKY.

Recurvidris* cf. *proles Bolton, 1992 (sp. 9 of SKY)

Collection data. Tourist area: w, 30.vi.2004, nest in soil, SKY (SR04-SKY-21).

Taxonomic notes. This species is very similar in size and structure to *R. proles*, but different from the latter in pilosity and color. In the specimens from Lambir the standing hairs on the propodeum are sometimes absent (if any, very short and weak) and standing hairs on antennal scape short (much less than width of scape), and the entire body yellow.

Biology. Forest; ground level; nests in soil.

Literature. Ohashi et al. (2017) (CO_2 emission from nests).

Genus *Rhopalomastix* Forel, 1900

Named Bornean species: 0 (Pfeiffer et al. 2011; only genus is listed); Lambir species: 1 (unidentified).

Unidentified species in *Rhopalomastix*: **sp. 6 of SKY** (Canopy 4 ha).

Genus *Tetramorium* Mayr, 1855

Named Bornean species: 27 (Pfeiffer et al. 2011). Lambir species: 30 (14 named, 16 unidentified). One species, *T. eleates*, is newly recorded from Borneo. *Rhoptromyrmex* Mayr, 1901 was synonymized with *Tetramorium* by Ward et al. (2014).

T. angulinode Santschi-group

Tetramorium smithi Mayr, 1879 (sp. 17 of SKY) (Pl. 2: 14)

Collection data. 8 ha plot: w, 18.iv.1993, SKY. HQ: w, 1–3.iii.1997, SKY. Tourist area: w, 22.iii.2013, nest in soil, SKY (SR13-SKY-05).

Biology. Disturbed sites; nest in soil with crater-shaped entrance (Pl. 2: 14).

T. bicarinatum (Nylander)-group

Tetramorium bicarinatum (Nylander, 1846) (sp. 42 of SKY)

Collection data. HQ: w, 7.i.1993, SKY; 1wq, 13–14.i.1993, SKY. Bt. Pantu: w, 16.i.1993, SKY.

Biology. Disturbed sites, forest trail; ground to lower vegetation; attracted to sugar baits.

Literature. Yamane et al. (1996).

Tetramorium insolens (F. Smith, 1861) (sp. 18 of SKY)

Collection data. 8 ha plot: w, 18.iv.1993, SKY. Inoue trail: w, 14.v.2011, SKY (SR11-SKY-22). 50 ha plot: w, 23.viii.1993, on *Macaranga trachyphylla* (A222), T. Itino. 'Lambir': 6.viii.1993, on *M. trachyphylla* seedling, T. Itino.

Tetramorium* cf. *obtusidens Viehmeyer, 1916 (sp. 70 of SKY)

Collection data. 'Lambir': w, 2.i.1998, SKY; w, 17.x.2005, C. Handa (CH0499); w, 19.x.2005, C. Handa (CH0509); w & fq, 14.v.2011, ex dead twig, SKY (SR11-SKY-22).

T. kheperra (Bolton)-group (part of *Tryglyphothrix* Forel, 1890)

Tetramorium* cf. *adpressum (Bolton, 1976) (sp. 1(a) of SKY)

Collection data. 8 ha plot: w, 6–31.i.1993, SKY; w, 12–13.i.1993, sugar bait (GN-1-11, -1-2, -2-9), SKY; w, 14.i.1993, sugar bait (G-2-9, 10, 13, 14), SKY; w, 19.iv.1993, SKY; w, 16.xii.1993, SKY; w, 3–7.viii.1995, SKY. 50 ha plot: w, 20.i.1993, SKY; w, 19.viii.1997, SKY; w, 30.xii.1997, SKY. Tourist area: w, 1.iii.1997, SKY. 'Lambir': w, 14.v.2011, cheese bait, SKY (SR11-SKY-24).

Biology. Forest; ground level; ex leaf litter and soil; attracted to sugar and cheese baits; active day and night.

Literature. Yamane et al. (1996), Ohashi et al. (2017) (CO_2 emission from nests, as *T. adpressum*).

Tetramorium meshena (Bolton, 1976) (sp. 37 of SKY) (Pl. 13: 52 [USI: B2356503])

Collection data. Tourist area: w, 25.i.1993, SKY.

Unidentified species in *Tetramorium kheperra*-group: **sp. 14 of SKY** (8 ha plot, Bt. Pantu & 50 ha plot); **sp. 23 of SKY** (8 ha plot; sugar bait; daytime; Yamane et al. 1996 as *T. chepocha*); **sp. 89 of SKY** (Tourist area).

T. lanuginosum Mayr-group (part of *Tryglyphothrix* Forel, 1890)

Tetramorium lanuginosum Mayr, 1870 (sp. 2 of SKY)

Collection data. 8 ha plot: w, 15.i.1993, SKY. HQ: w, 19.iii.1995, SKY; w, 14.v.2011, at light, SKY. 'Lambir': w, 14–19.viii.1997, SKY.

Biology. Disturbed sites; attracted to cheese baits; active day and night.

T. pacificum Mayr-group

Tetramorium pacificum Mayr, 1870 (sp. 6 of SKY)

Collection data. Bt. Pantu: w, 16.i.1993, SKY.

Biology. Forest; ground level.

Tetramorium scabrum Mayr, 1879 (sp. 68 of SKY)

Collection data. Bt. Lambir: w, 12.i.1993, <400 m alt., SKY.

Biology. Forest; ground level.

Tetramorium* cf. *scabrum Mayr, 1879

Collection data. 8 ha plot: w, 30.xii.1997, SKY. 50 ha plot: w, 7.i.1993, SKY. 'Lambir: w, 2.i.1998, SKY; w, 19.ix.2006, HOT (HOT-014, 018, 315).

Taxonomic notes. In metric characters this species is intermediate between *T. pacificum* and *T. scabrum*.

Biology. Forest; ground level.

Unidentified species in *T. pacificum*-group: **sp. 69 of SKY** (8 ha plot & 'Lambir').

T. scabrosum (F. Smith)-group

Tetramorium aptum Bolton, 1977 (sp. 11 of SKY)

Collection data. 8 ha plot: w, 13.i.1993, sugar bait (GN-2-5), SKY. 50 ha plot: w, 22.viii.1995, SKY. 'Lambir': w, 14.viii.1997, SKY; w, 5.viii.2004, HOT (ground 04-251); 6.viii.2004, HOT (ground 04-096).

Biology. Forest; ground level to lower vegetation; attracted to sugar baits; active in night.

Literature. Yamane et al. (1996).

Tetramorium curtulum Emery, 1895 (sp. 3 of SKY)

Collection data. 8 ha plot: w, 15.i.1993, SKY; w, 15.i.1993. sugar bait (G-3-12, 13); w, 10.xii.1993, SKY; w, 26–27.viii.1994, T. Itioka & T. Yumoto (#21, 125); w, 3.i.1998, SKY. Tourist area: w, 22.i.1993, SKY; w, 30.vi.2004, SKY (SR04-SKY-29). Inoue trail: w, 2.vii.2004, SKY; w, 24.iii.2013, SKY. 50 ha plot: w, 27.i.1993, SKY; w, 24.iii.2013, SKY. 'Lambir': w, 21.x.1993, 2WA-0, T. Yumoto; w, 14.v.2011, SKY.

Biology. Forest; ground level; ex leaf litter; attracted to sugar baits; active day and night. One of the most common *Tetramorium* in Lambir.

Literature. Yamane et al. (1996), Ohashi et al. (2017; CO_2 emission from nests).

Tetramorium* cf. *parvum Bolton, 1977 (sp. 4 of SKY)

Collection data. 8 ha plot: w, 14.viii.1995, SKY. 50 ha plot: w, 22.viii.1995, SKY. Sungai Liku: w, 28.vi.2004, SKY. 'Lambir': w, 3.vii.2004, SKY.

Biology. Forest; ground level.

Literature. Ohashi et al. (2017; CO_2 emission from nests; as *T. parvum*).

T. simillimum (F. Smith)-group

Tetramorium simillimum (F. Smith, 1851) (sp. 48 of SKY)

Collection data. Tourist area: w, 24.i.1993, SKY. HQ: w, 7.i.1993, SKY.

Biology. Disturbed sites; ground level.

T. tonganum Mayr-group

Tetramorium laparum Bolton, 1977 (sp. 9 of SKY)

Collection data. 8 ha plot: w, 30.i.1993, sugar bait (T-1-1), SKY; w, 15.viii.1997, tree tower, SKY. 'Lambir': w, 30.viii.1993, sugar bait at 25 m above ground, T.

Itino; w, xii.2003–iii.2004, HOT & T. Itioka (DAT133, 423); w, 11.vii.2005, 18 m above ground, AA656, HOT (AT833); w, 19.vii.2005, F4, AA656, HOT (AT874).

Biology. Forest; foragers on tree trunk from near ground to subcanopy; attracted to sugar baits; active in daytime.

Literature. Itino & Yamane (1995), Yamane et al. (1996), Tanaka & Itioka (2012).

Tetramorium ocothrum Bolton, 1979 (sp. 5 of SKY) (Pl. 14: 53 [USI: B2356504])

Collection data. 8 ha plot: w, 3.viii.1995, SKY; w, 17.viii.1995, ex epiphyte, T. Yumoto. Bt. Lambir: w, 12.i.1993, summit (450 m alt.), SKY. 'Lambir': w, xii.2003–iii.2004, HOT & T. Itioka (DAT309); w, 15.v.2011, leaf litter on palm, SKY (SR11-SKY-30).

Biology. Forest; foragers on tree trunks; nests on trees (in epiphytes, in aerial soil).

Literature. Tanaka et al. (2010).

T. tortuosum Roger-group

****Tetramorium eleates*** Forel, 1913 (sp. 39 of SKY)

Collection data. 8 ha plot: w, 30.i.1993, SKY; w, 18.iv.1993, SKY. Tourist area: w, 25.i.1993, SKY; w, 31.xii.1997, F. Yamane. HQ: w, 3–20.viii.1995, SKY.

Biology. Forest & disturbed forest; ground level.

Tetramorium palaense Bolton, 1979 (sp. 7 of SKY) (Pl. 14: 54 [USI: B2356505])

Collection data. 8 ha plot: w, 6–11.i.1993, SKY; w, 13.i.1993, sugar bait (G-1-9), SKY; w, 15.i.1993, sugar bait (G-3-7, 12), SKY; w, 10.xii.1993, SKY; w, 1.iii.1997, SKY; w, 30.xii.1997, SKY; w, 8.i. 1998, F. Yamane; w, 30.vi.2004, rotting wood, SKY (SR04-SKY-53); w, 30.vi.2004, SKY. Tourist area: w, 20.i.1993, SKY; w, 15.xii.1993, SKY; w, 2.i.1998, SKY; w, 20.vi.2004, SKY (SR04-SKY-20). Inoue trail: w, 2.vii.2004, SKY (SR04-SKY-42). Bt. Lambir: w, 13–14.viii.1995, J. Otsubo; w, 22.viii.1995, SKY. 'Lambir': w, 21.vi.1998, K. Eguchi (Eg98-BOR-810); w, 5.viii.2004, HOT (ground 04-068); w, 14.v.2011, cheese bait, SKY; w, 15.v.2011, rotting wood, SKY (SR11-SKY-28).

Biology. Forest; ground level; nests in rotting wood; attracted to sugar and cheese baits; active day and night. This is the most common *Tetramorium* on forest floor of Lambir.

Literature. Yamane et al. (1996), Tanaka et al. (2010), Ohashi et al. (2017; CO_2 emission from nests).

T. wroughtonii (Forel)-group (=*Rhoptromyrmex* Mayr, 1901)

Rhoptromyrmex was synonymized with *Tetramorium* by Ward et al. (2014).

Tetramorium* cf. *rawlinsoni (Taylor, 1992) (*Rhoptromyrmex* sp. 3 of SKY)

Collection data. Tourist area: w, 30.i.1993, SKY. Bt. Lambir: 12.i.2003, SKY.

Taxonomic notes. *Rhoptromyrmex rawlinsoni* was described by Taylor (1992) based on a single alate queen from Anak Krakatau in the Sunda Strait, Indonesia. Taylor suspected that this species is a workerless inquiline species, probably parasitic on *R. wroughtonii* Forel, 1902, which was also found on Anak Krakatau. A strongly produced anterior margin of the clypeus characterizes this species. However, Yamane (2013) collected a colony with workers having a similar condition (but unfortunately queens were not found), and suggested *R. rawlinsoni* may not be an inquiline. To resolve this problem colony samples with both the queens and workers are needed.

Biology. Forest edge; ground level.

Tetramorium* cf. *wroughtonii (Forel, 1902) (*Rhoptromyrmex* sp. 2 of SKY) (Pl. 14: 55 [USI: B2356506])

Collection data. 8 ha plot: w, 30.i.1993, SKY. Tourist area: w, 25.i.1993, SKY.

Taxonomic notes. The so-called *Tetramorium wroughtonii* may be a species complex. No complete treatment of this group is available.

Biology. Forest; ground level; attracted to cheese and sugar baits; visiting *Endospermum* extrafloral nectaries.

Unidentified species in *Tetramorium* (species groups not identified): **sp. 10 of SKY** (8 ha plot; attracted to sugar bait; Yamane et al. 1996); **sp. 20 of SKY** (50 ha plot); **sp. 25 of SKY** (8 ha plot); **sp. 29 of SKY** ('Lambir'); **sp. 65 of SKY** ('Lambir'; DAT351, 383); **sp. 75 of SKY** (? *ciliatum* group; Tourist area and 'Lambir'; LL8-37, A7, in soil).

Genus *Vollenhovia* Mayr, 1865

Named Bornean species: 8 (Pfeiffer et al. 2011). Lambir species: 14 (4 named, 10 unidentified). Two species, *V. longichephala* and *V. modiglianii*, are newly recorded from Borneo.

Vollenhovia* cf. *butteli Forel, 1913 (sp. 8 of SKY)

Collection data. 50 ha plot: w, 22.viii.1995, SKY.

Vollenhovia fridae Forel, 1913 (sp. 1 of SKY) (Pl. 15: 56 [USI: B2356507])

Collection data. 8 ha plot: w, 22–26.i.1993, SKY; w, 13.iii.2011, at night, SKY (SR11-SKY-09). Tourist area: w, 25.i.1993, SKY; w, 30.xii.1997, SKY; w, 31.xii.1997, F. Yamane. Inoue trail: w, 2.vii.2004, SKY. Bt. Pantu: w, 16.i.1993, SKY. 50 ha plot: w, 27.i.1993, SKY. LUBL F4: w, 26.vi.2004, rotting wood, SKY. Sungai Liku: w, 26.vi.2004, SKY.

Taxonomic notes. Males of this species from Borneo well agree with the original description of the type male of *V. penetrans* (F. Smith, 1857) (Yamane et al.,

unpubl.). This species is also very similar to *V. pertinax* (F. Smith, 1861) from Sulawesi.

Biology. Forest; ground level; nest in rotting wood; active day and night. This is a very common species throughout Southeast Asia.

****Vollenhovia longicephala*** (Terayama et Yamane, 1991) (sp. 29 of SKY)

Collection data. 8 ha plot: fq, 11.i.1993, SKY; w, 10.xii.1993, SKY.

****Vollenhovia modiglianii*** Emery, 1900 (sp. 21 of SKY)

Collection data. 8 ha plot: w, 11.i.1993, SKY.

Vollenhovia rufiventris Forel, 1901 (sp. 7 of SKY)

Collection data. 'Lambir': w, 15.viii.1997, SKY.

Unidentified species in *Vollenhovia*: **sp. 2 of SKY** (8 ha plot, Tourist area & 50 ha plot), **sp. 3 of SKY** ('Lambir', rotting wood), **sp. 4 of SKY** (8 ha plot; Tanaka et al. 2010, Tanaka & Itioka 2012), **sp. 46 of SKY** ('Lambir'), **sp. 47 of SKY** ('Lambir', DAT333; Tanaka et al. 2010), **sp. 58 of SKY** (Tourist area & Canopy 4 ha, P2B15), **sp. 59 of SKY** (Canopy 4 ha, P1B8 & P2B15), **sp. 65 of SKY** (Canopy 4 ha, P6B10, P7B12, P9B10 & P10B10), **sp. 71 of SKY** (Inoue trail & 'Lambir'), **sp. 74 of SKY** (8 ha, SR04-SKY-58).

Genus *Vomvisidris* Bolton, 1991

Named Bornean species: 4 (Bolton 1991; Pfeiffer et al. 2011). Lambir species: 1 (unidentified).

Unidentified species in *Vomvisidris*: **sp. 7 of SKY** ('Lambir', ant-mimic sample).

Subfamily Pseudomyrmecinae

This subfamily consists of only two genera, i.e., *Pseudomyrmex* Lund, 1831 (New World) and *Tetraponera* (Old World). The Oriental and Australian species of *Tetraponera* were revised by Ward (2001).

Genus *Tetraponera* F. Smith, 1852

Named Bornean species: 16 (Ward 2001; Pfeiffer et al. 2011). Lambir species: 13 (12 named and 1 unidentified). Two species, *T. vivax* and *T. volcuris*, are newly recorded from Borneo.

T. allaborans species group

Tetraponera allaborans (Walker, 1859) (sp. 3 of SKY)

Collection data. 8 ha plot: w, w, 6.i.1993, 35 m above ground, SKY. Canopy 4 ha: w, 5.iii.2004, HOT.

Biology. Forest; arboreal.

Literature. Ward (2001).

Tetraponera bita Ward, 2001 (sp. 40 of SKY)

Collection data. 'Lambir': w, 10.xii.2005, 30 m above ground, HOT (AT1152); w, vi–viii.2004, HOT & T. Itioka.

Biology. Forest; arboreal.

Tetraponera extenuata Ward, 2001 (sp. 2 of SKY)

Collection data. Bt. Lambir: 12–14.viii.1995, 200 m alt., J. Otsubo.

Tetraponera modesta (F. Smith, 1860) (sp. 10 of SKY)

Collection data. 8 ha plot: w, 1994, walkway, SKY. 'Lambir': w, xii.2003–iii.2004, HOT & T. Itioka (DAT040); w, 3–12.ix.2009 (ant-mimic sample #242).

Biology. Forest; arboreal.

T. nigra species group

Tetraponera attenuata F. Smith, 1877 (sp. 1 of SKY; = *sp. 7 of SKY*) (Pl. 15: 57 [USI: B2356508])

Collection data. 8 ha plot: w, 6.i.1993, 35 m above ground, SKY; w, 26.i.1993, SKY; w, 25.viii.1993, sugar bait, T. Itino; w, 23–24.viii.1995, tree tower to walkway, SKY; w, 30.xii.1997, walkway, SKY. Tourist area: w & wq, 2–24.i.1993, SKY; w, 2.iii.1997, SKY. Bt. Pantu: w, 2.1.1993, F. Yamane. 50 ha plot: w, 27.i.1993, SKY. 'Lambir': w, 30.x.1996, Y. Hashimoto.

Biology. Forest; foraging on trees and also on ground surface; nests in canopy; attracted to arboreal honeydews and sugar baits; active in daytime.

Literature. Itino & Yamane (1995), Ward (2001), Hyodo et al. (2011), Tanaka & Itioka (2012).

Tetraponera difficilis (Emery, 1900) (sp. 16 of SKY; = *sp. 9* [part], *20, 22 of SKY*)

Collection data. HQ: w, 3–20.viii.1995, SKY.

Tetraponera inversinodis Ward, 2001 (sp. 9 of SKY)

Collection data. 'Lambir': w, 16.viii.2001 (CR00079).

Biology. Often found together with *Crematogaster* cf. *cylindriceps* in climber plants (see under the latter species).

Tetraponera nigra (Jerdon, 1851) (sp. 24 of SKY)

Collection data. HQ: w, 7–20.viii.1995, SKY.

Tetraponera nitida (F. Smith, 1860) (sp. 11 of SKY)

Collection data. 8 ha plot: w, 11.viii.1995, SKY. Canopy 4 ha: w, 5.iii.2004. HOT (P4B4-2).

Literature. Ward (2001).

****Tetraponera vivax*** (Ward, 2001)

Collection data. Canopy 4 ha: fq, 5.iii.2004, HOT (P4B1-2).

****Tetraponera volucris*** Ward, 2001 (sp. 39 of SKY)

Collection data. 'Lambir': w, fq, 26.ix.2005, walkway, HOT.

Biology. Forest; arboreal.

Unidentified species in *Tetraponera nigra* group: **sp. 42 of SKY** (Tourist area).

T. pilosa species group

Tetraponera pilosa (F. Smith, 1858) (sp. 6 of SKY) (Pl. 15: 58 [USI: B2356509])

Collection data. 8 ha plot: w & wq, 6.vii.2004, nest in living twig in canopy, HOT (AT0285); w & m, 6.vii.2004, 30 m above ground, nest in living twig, HOT. Canopy 4 ha: w, 3.iii.2004, HOT (P1B14).

Biology. Forest; arboreal; nests in living twigs, often found together with *Crematogaster* cf. *cylindriceps* in climber plants (see under the latter species).

Literature. Tanaka & Itioka (2012).

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Explanation of plates

Plate 1. **1:** Canopy seen from the gondola (Photo: SKY, 2 July 2004). **2:** Hiroshi O. Tanaka climbing a tall tree. **3:** Sweeping insects from the gondola in Canopy 4 ha plot (Crane site) (Photo: T. Itioka). **4:** Collecting a huge birds-nest fern to examine inside fauna (Photo: T. Itioka, September 2009). **5:** Epiphyte (*Platycerium ridleyi*) housing a *Crematogaster difformis* colony (Photo: HOT). **6:** Epiphyte (*Lecanooteris crustacea*), another nest site for *C. difformis* (Photo: HOT). **7:** Nest of *C. difformis* in *P. ridleyi* (Photo: T. Itioka).

Plate 2. **8:** Buttress tree characteristic of tropical rainforest. **9:** Forest floor and lower vegetation. **10:** *Shorea macrophylla* seedlings, which bear EFNs attracting various ants on the stipules and leaves (Photo: SKY, 23 March 2013). **11:** Line transect for CO_2 emission measurement (soil ants were sampled at each point) (Photo: M. Ohashi). **12:** *Crematogaster* workers attracted to extrafloral nectaries of *Shorea macrophylla* (Photo: SKY, 23 March 2013). **13:** *Crematogaster inflata* colony with scale insects on a stem of *Poikilospermum* sp. **14:** Crater-like nest entrance of *Tetramorium smithi* (Photo: SKY, 22 March 2013). **15:** *Myrmicaria brunnea* group workers attending tree hoppers (Membracidae) on a liana, *Uncaria* sp. (Rubiaceae) (Photo: U. Shimizu-kaya, 26 November 2015).

Plate 3. **16:** *Crematogaster* partner ants on a young stem and leaf of *Macaranga trachyphylla*. **17:** Young leaves of *Macaranga hypoleuca*; some workers of its partner ant *C. decamera* collecting white food bodies on adaxial surface of leaves (Photo: SKY, 22 March 2013). **18:** Workers of *Crematogaster borneensis*-group attending a larva of the lycaenid *Arhopala dajagaka* on a leaf of *Macaranga rufescens* (Photo: T. Okubo). **19:** Invader ant, *Crematogaster* sp. 144 of SKY, on *Macaranga winkleri* stem (Photo: SKY, 22 March 2013). **20:** Nest of *C.* sp. 144 of SKY in *M. winkleri* stem (Photo: ditto). **21:** Carton nest of *Monomorium* sp. 5 of SKY (Photo: SKY, 23 March 2013). **22:** Nest surface of *M.* sp. 5 (Photo: ditto).

Plate 4. **23:** *Aphaenogaster* sp. 26 of SKY, worker (30.vi.2004, SKY leg., SR04-SKY-23) [USI: B2356474]. **24:** *Myrmicaria melanogaster* Emery, 1900, worker (10.ix.2006, HOT leg., AT1193) [USI: B2356475]. **25:** *Monomorium* sp. 5 of SKY, worker (23.iii.2013, SKY leg., SR13-SKY-17) [USI: B2356476]. **a:** head in full-face view, **b:** habitus in profile. (Photos: Y. Hashimoto)

Plate 5. **26:** *Syllophopsis australicus* (Forel, 1907), worker (15.i.1993, SKY leg.) [USI: B2356477]. **27:** *Pheidole plagiaria* F. Smith, 1860, minor worker (20.i.1993, SKY leg.) [USI: B2356478]. **28:** ditto, major worker (ditto, GN3-8) [USI: B2356479]. **a:** head in full-face view, **b:** habitus in profile. (Photos: Y. Hashimoto)

Plate 6. **29:** *Strumigenys mitis* (Brown, 2000) (former *Pyramica mitis*), worker (11.viii.1998, T. Itino leg.) [USI: B2356480]. **30:** *Strumigenys sublaminata* Brown, 1959, worker (2.vii.2004, SKY leg.) [USI: B2356481]. **31:** *Acanthomyrmex ferox* Emery, 1893, minor worker (11.viii.1995, SKY leg.) [USI: B2356482]. **a:** head in full-face view, **b:** habitus in profile. (Photos: Y. Hashimoto)

Plate 7. **32:** *Calyptomyrmex danum* Shattuck, 2011, worker (2.vii.2004, SKY leg., SR04-SKY-80) [USI: B2356483]. **33:** *Cardiocondyla* sp. 4 of SKY, worker

(24.i.1993, SKY leg.) [USI: B2356484]. **34:** *Cataulacus horridus* F. Smith, 1857, worker (2.i.1998, F. Yamane leg.) [USI: B2356485]. **a:** head in full-face view, **b:** habitus in profile. (Photos: Y. Hashimoto)

Plate 8. **35:** *Carebara* sp. (*Oligomyrmex* sp. 1 of SKY), minor worker (2.vii.1997, SKY leg.) [USI: B2356486]. **36:** ditto, major worker (same data) [USI: B2356487]. **37:** *Dacetinops cirrosus* Taylor, 1985, worker (2.vii.2004, SKY. leg., SR04-SKY-45) [USI: B2356488]. **a:** head in full-face view, **b:** habitus in profile. (Photos: Y. Hashimoto)

Plate 9. **38:** *Carebara pygmaea* (Emery, 1887) (former *Pheidologeton pygmaeus*), minor worker (3.iii.1997, SKY leg.) [USI: B2356489]. **39:** ditto, major worker (same data) [USI: B2356490]. **40:** *Crematogaster modiglianii* Emery, 1900, worker (31.xii.1997, SKY leg., SR97-SKY-03) [USI: B2356491]. **a:** head in full-face view, **b:** habitus in profile. (Photos: Y. Hashimoto)

Plate 10. **41:** *Crematogaster* cf. *cylindriceps* Wheeler, 1927, worker (26.vi.2004, SKY leg., SR04-SKY-04) [USI: B2356492]. **42:** ditto, queen (same data) [USI: B2356493]. **43:** *Crematogaster inflata* F. Smith, 1857, worker (19.v.2011, SKY leg.) [USI: B2356494]. **a:** head in full-face view, **b:** habitus in profile. (Photos: Y. Hashimoto)

Plate 11. **44:** *Dilobocondyla* sp. 5 of SKY, worker (15.viii.1995, T. Yumoto leg.) [USI: B2356495]. **45:** *Gauromyrmex* cf. *bengakalisi* Menozzi, 1933, worker (30.xii.1997, SKY leg.) [USI: B2356496]. **46:** *Lophomyrmex longicornis* Rigato, 1994, worker (30.xii.1997, SKY leg.) [USI: B2356497]. **a:** head in full-face view, **b:** habitus in profile. (Photos: Y. Hashimoto)

Plate 12. **47:** *Meranoplus castaneus* F. Smith, 1857, worker (15.viii.1997, SKY leg.) [USI: B2356498]. **48:** *Myrmecina* cf. *bandarensis* Forel, 1913, worker (18.iv.1993, SKY leg.) [USI: B2356499]. **49:** *Pristomyrmex costatus* Wang, 2003, worker (22.viii.1995, SKY leg.) [USI: B2356500]. **a:** head in full-face view, **b:** habitus in profile. (Photos: Y. Hashimoto)

Plate 13. **50:** *Proatta butteli* Forel, 1912, worker (16.i.1993, SKY leg.) [USI: B2356501]. **51:** *Recurvidris browni* Bolton, 1992, worker (30.vi.2004, SKY leg., SR04-SKY-30) [USI: B2356502]. **52:** *Tetramorium meshena* (Bolton, 1976), worker (25.i.1993, SKY leg.) [USI: B2356503]. **a:** head in full-face view, **b:** habitus in profile. (Photos: Y. Hashimoto)

Plate 14. **53:** *Tetramorium ocothrum* Bolton, 1979, worker (15.v.2011, SKY leg., SR11-SKY-30) [USI: B2356504]. **54:** *T. palaense* Bolton, 1979, worker (2.i.1998, SKY leg.) [USI: B2356505]. **55:** *T.* cf. *wroughtonii* (Forel, 1902), worker (30.i.1993, SKY leg.) [USI: B2356506]. **a:** head in full-face view, **b:** habitus in profile. (Photos: Y. Hashimoto)

Plate 15. **56:** *Vollenhovia fridae* Forel, 1913, worker (26.i.1993, SKY leg.) [USI: B2356507]. **57:** *Tetraponera attenuata* F. Smith, 1877, worker (2.iii.1997, SKY leg.) [USI: B2356508]. **58:** *T. pilosa* (F. Smith, 1858), worker (6.vii.2004, HOT leg.) [USI: B2356509]. **a:** head in full-face view, **b:** habitus in profile. (Photos: Y. Hashimoto)

Plate 1 (pic 1–7)

Plate 2 (pic 8–15)

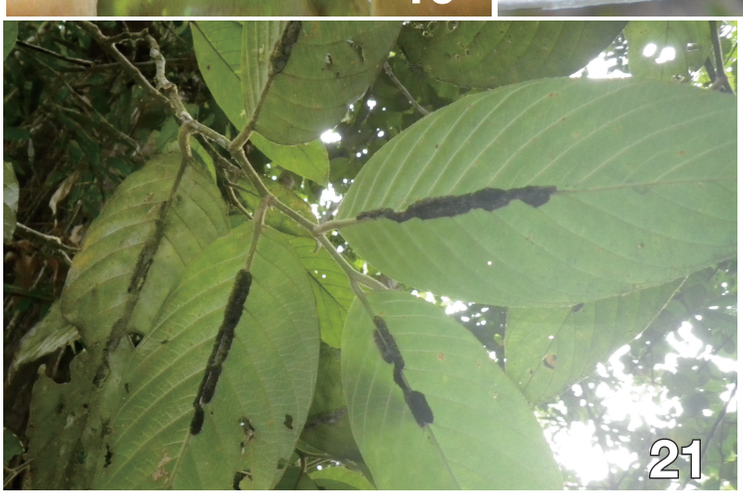

Plate 3 (pic 16–22)

Plate 4 (pic 23–25)

Plate 5 (pic 26–28)

Plate 6 (pic 29–31)

Plate 7 (pic 32–34)

Plate 8 (pic 35–37)

Plate 9 (pic 38–40)

Plate 10 (pic 41–43)

Plate 11 (pic 44–46)

Plate 12 (pic 47–49)

Plate 13 (pic 50–52)

Plate 14 (pic 53–55)

Plate 15 (pic 56–58)

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